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POWER

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NEW YORK, JANUARY 30, 1912.

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Outline of Topics, 64.
Index to Advertisers, 54.

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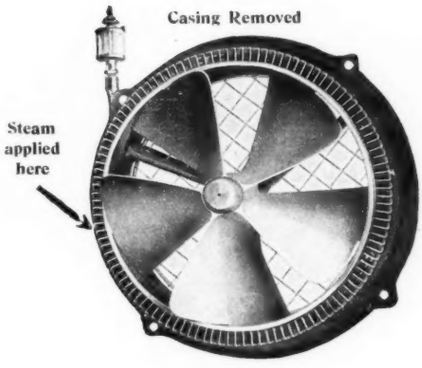

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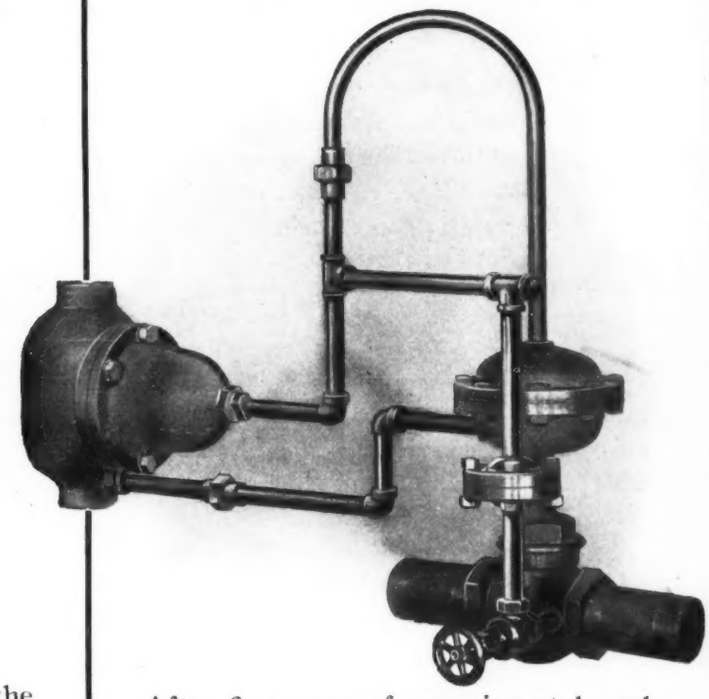

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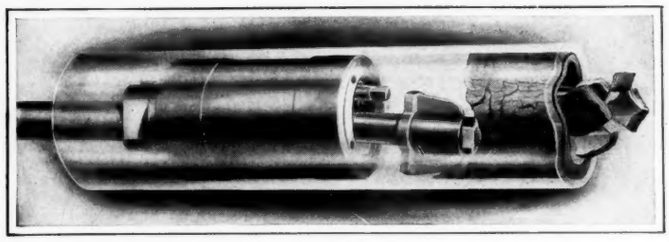

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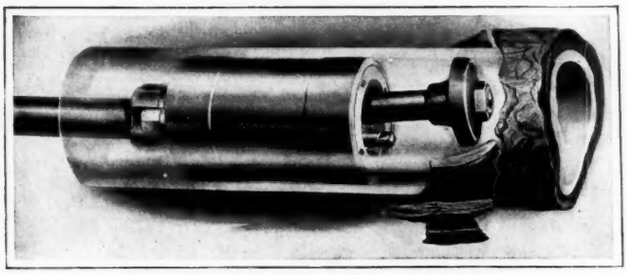

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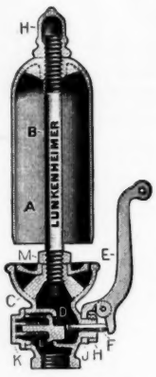

Fig. 441.
Plain All Brass Whistle with Valve.

Lunkenheimer Whistles

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Fig. 446.
Combination Fire Alarm Whistle with Valve.

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Fig. 443.
Iron Base Brass Bell Whistle without Valve.

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Fig. 445.
"Mocking-bird" Whistle with Valve.

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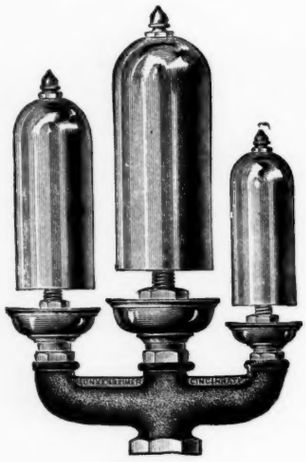

Fig. 450.
Three-whistle Chime.

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Fig. 691.
Balanced Whistle Valve, Screw Ends.

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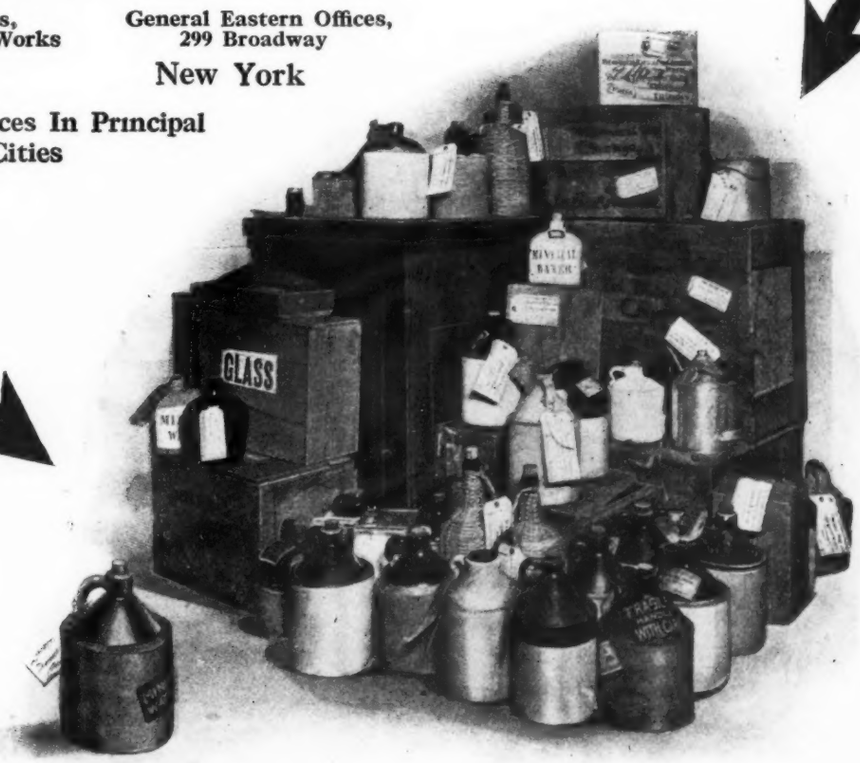

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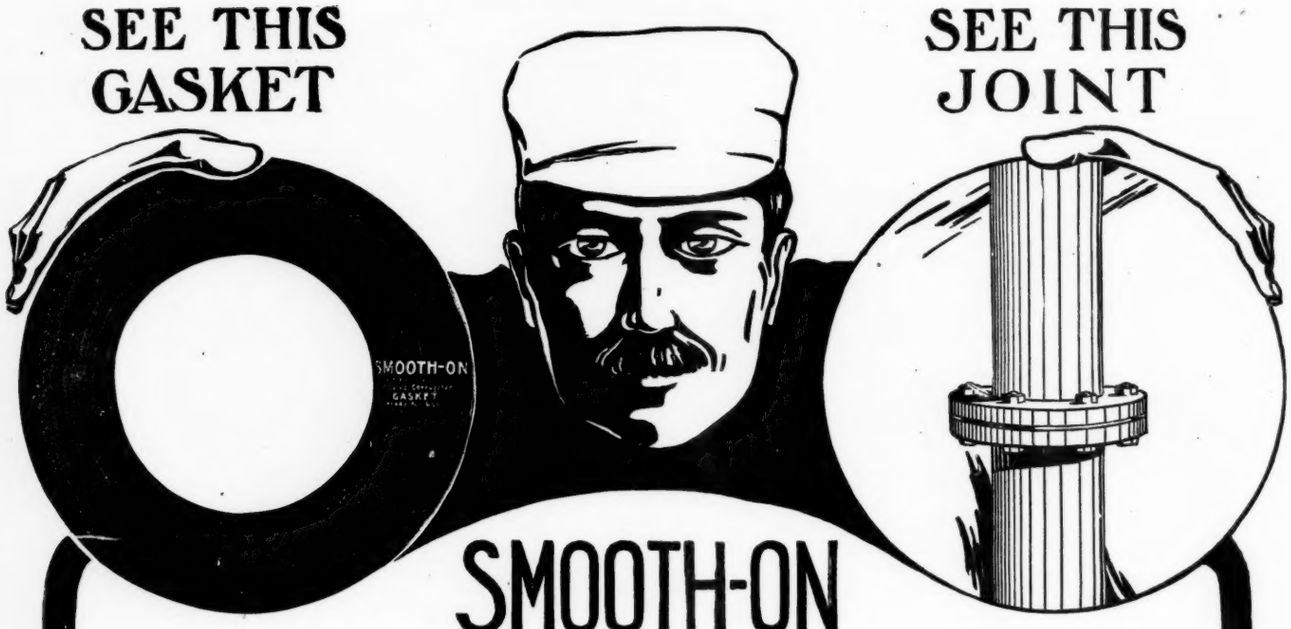

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POWER

Vol. 35 NEW YORK, JANUARY 30, 1912 No. 5

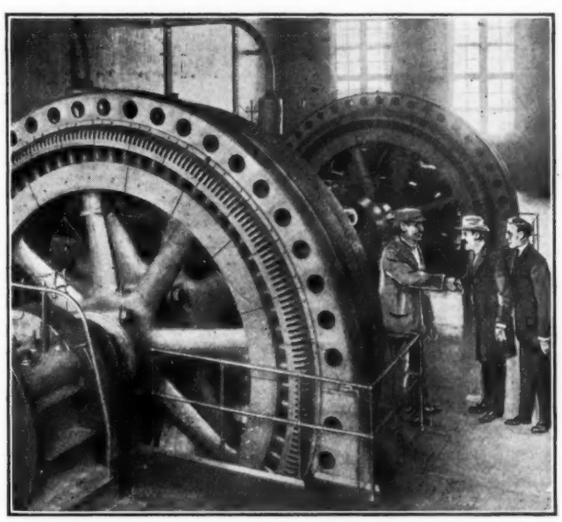
THIS is not a fairy tale. It is a truthful picture of what took place a few days ago and the conditions mentioned herein actually obtained.

The writer visited a modern power plant which was a work of engineering art. Many dollars had been spent in devices which improved the appearance of the plant and were for the accommodation of the employees rather than for safety and economy.

The engine and boiler rooms were large and light and the machinery was arranged with an eye to symmetry. There was a washroom equipped with a shower bath; also a tub and hot and cold water for the engineers and firemen.

There is some difference between this and the old way of washing up in a pail of hot water out in the boiler room, where the soap was full of cinders and the towel often trailed in the dirt while hanging from a hip pocket.

The owners of this power plant were proud of their installation, and justly so. Of course, it was expected that the chief engineer would be in keeping with his surroundings, but when the introduction came it was noticed that his hands were dirty; his vest showed signs of soup droppings and the lapel and collar of his coat were greasy—in short, he was sloppy.



But how differently appeared his subordinates!

Out in the boiler room the firemen were found to be a clean-looking set of men, and the chief engineer's appearance was not improved by the comparison.

When we were alone the owner apologized for his engineer's appearance. He could not understand why so skilled a mechanic could be content to remain so unkempt. He expressed the hope that some time his engineer would clean up and put himself in keeping with the rest of the plant.

Think of it, the owner making apologies for the dirty appearance of his engineer!

Getting down to rock bottom, what does the owner of your plant think of you? Is he obliged to make apologies for your appearance? Is he ashamed of your looks when visitors are about?

Are the firemen and oilers neater than their chief?

Small boys and dogs are usually dirty. It is expected of them; the boy is so busy playing that he has no time for soap and water. The dog doesn't know any better. But men having a bathtub and hot and cold water at their disposal—conveniences which our grandfathers never heard of—have no excuse for being unclean and slovenly.

Line up with your plant and then there will be no need of apologies by the plant owner.

British Practice in Superheating

By Victor White

The advantages of using a moderate degree of superheat are discussed and a number of types of superheaters used extensively in England, are described.

The addition of a moderate amount of superheat effects a saving of steam even in well arranged modern power plants, and where the engines are separated from the boilers by long lengths of steam piping, the advantages of superheating are marked. In a reciprocating engine the benefit is evidenced in the raising of the expansion curve of the indicator diagram, and the effect of reëvaporation toward the end of the stroke is not so marked. Apart from the losses in the steam piping, with the necessity for an elaborate and wasteful system of traps, and the lost work due to initial condensation in the cylinder, saturated steam escapes more freely past the pistons and valves.

In Fig. 1 are shown the results of tests with superheated steam carried out by Bellıss & Morcom, Ltd., of Birmingham, on one of their high-speed triple-expansion engines, which is self-explanatory. It

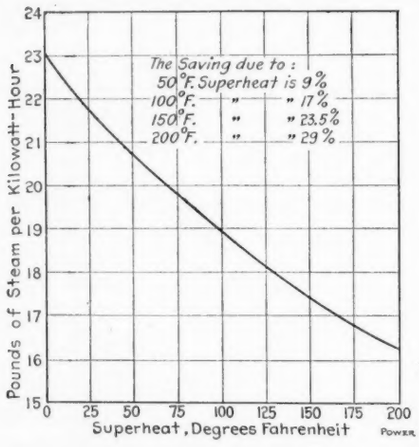


FIG. 1. STEAM CONSUMPTION WITH VARIOUS DEGREES OF SUPERHEAT

has also been amply demonstrated by operating results that the use of superheated steam is of great value in turbine practice, and here, due to the absence of lubrication in the steam spaces, superheating can be carried so high that the steam possesses practically the properties of a perfect gas.

Having regard to these points, it is therefore interesting to note some of the latest designs which now find a place in British superheater practice. Given a proper heat-transmission efficiency from the gases to the steam to be superheated, the determining factors as to the excellence of design are mechanical strength, accessibility and reliability of operation. Controllability is also very important, particularly in independently fired superheaters, where the steam demands vary, for if a very small quantity of steam passes through the superheater while a full blast of heat is upon the tubes, the degree of superheat would be much greater than when a heavy load and a scanty heat supply were prevalent. A superheater must always be designed to give full (or even a small excess) superheat under the worst conditions of load; therefore it should have means for controlling during light loads. Moreover, if there were no such control the probability is that under the first of these conditions the tubes would become overheated and would be liable to burn.

Where several large boilers are used, it has often been found less expensive and better in operation to have one large independently fired superheater serving the whole range of boilers instead of including a small superheater in each steam unit.

WATKINSON SUPERHEATER

A type of superheater, designed by Professor Watkinson, of the Liverpool University, and made by Mechan & Sons, Ltd., of Glasgow, is shown in Fig. 2. As applied to a Lancashire boiler, the superheater is placed in a separate compartment behind the rear chamber of the boiler, being separated therefrom by a perforated firebrick wall, underneath which a damper is placed. When the damper is in the vertical position the products of combustion do not flow over the superheater tubes, but pass direct to the bottom flue of the boiler. When the damper is in the horizontal position, all the gases flow over the superheater tubes and, by varying the position of the damper between these limits, the degree to which the steam is superheated may be regulated. This control gear is operated from the front of the boiler, as shown, and the hot gases can be shut off from the superheater during the time steam is being raised or when the engine is not running. In some types the tubes become red hot whenever the engine is stopped, and provision has to be made for "flooding" the superheater; that is, filling it with water so that the apparatus may not be damaged. This is often considered objectionable as it may cause rapid deterioration of the tubes and lead to dangerous water-hammer. The damper, being protected from the high-temperature gases, does not suffer undue deterioration, and the firebrick wall between the boiler and the superheater acts as a heat reservoir, maintaining the temperature of the gases when the furnace doors are open. The brickwork also absorbs heat during periods of most rapid combustion, and thus acts as a regulator of the temperature of the gases supplied to the superheater. With the Watkinson superheater, the heat utilized per pound of coal burned, when the rate of evaporation remains the same, is increased by about 5 per cent., owing to the additional heat-absorbing surface of the superheater. The amount of heat required to superheat the steam 150 degrees Fahrenheit is about 7 per cent. of that required to generate the steam; therefore, the additional coal required to superheat the steam is only 2 per cent. The superheater is constructed entirely

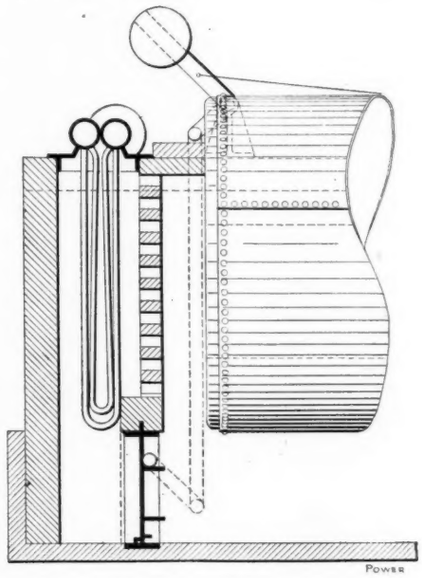


FIG. 2. WATKINSON SUPERHEATER

of mild steel and the solid-drawn tubes are expanded into the header. All the joints and headers are removed from the direct path of the gases and provision is made for free expansion of the tubes.

MCPHAIL & SIMPSON SUPERHEATER

A McPhail & Simpson superheater placed in the downtake of a boiler is shown in Fig. 3. Tubes can be removed if necessary from the boiler top without disturbing the working of the steam plant, by a slight modification of the headers. No damper is employed and the superheater, which is constructed entirely of solid-drawn wrought steel, does not interfere with the accessibility of the boiler itself. The headers are strongly supported on the boiler setting, and a safety valve and thermometer pockets are provided.

Another type of superheater used extensively in England is the Foster. This is so well known in America, however, that a description would be unnecessary for the readers of POWER.

GORDON SUPERHEATER

A superheater of distinctive design which has been used extensively in England, is the sectional superheater made by James Gordon & Co., of London. The construction will be understood by reference to Fig. 4, which represents a collection of the component parts of the superheater. All the parts are of wrought steel and the sectional design is to prevent that more or less lengthy stoppage which is necessary in some superheaters when a tube has to be removed or reëxpanded. If a tube requires attention or a joint remaking, it is necessary only to remove that section of tubes, replace it with a spare section, drop in fresh joint rings or put on blank flanges, which are provided for the purpose; all this can be done with the boiler under steam. There is no large joint to break and remake, involving the removal of a large number of bolts, disturbing pipe joints and finishing with the troublesome task of remaking the joint again, and there is no wasting of heating surface by the "stoppering" of defective tubes. All the joints are so situated as to be out of the path of the flue gases, and can be examined while the plant is working. Owing to the sectional design, no lifting tackle is required for erection, the headers being first placed in position and then the tubes put in and assembled section by section.

It is sometimes an advantage to combine with the superheater a damper arrangement to partially or entirely bypass the flue gas during periods of inspection or when raising steam, or if required for reducing the amount of superheat. The type of damper used by James Gordon & Co. is in the nature of a horizontal baffle capable of being moved vertically and suspended on rods which are raised or lowered from the front of the boiler. In its lower position the furnace gases are projected past the superheater tubes, and when it is raised they choose a shorter path in the downtake, missing the tubes. This type of damper has been adopted with a view to overcoming some of the difficulties which are met with in ordinary swivel dampers, such as the damper spindles warping and jamming, or distortion of the swivel damper itself, owing to the high temperatures.

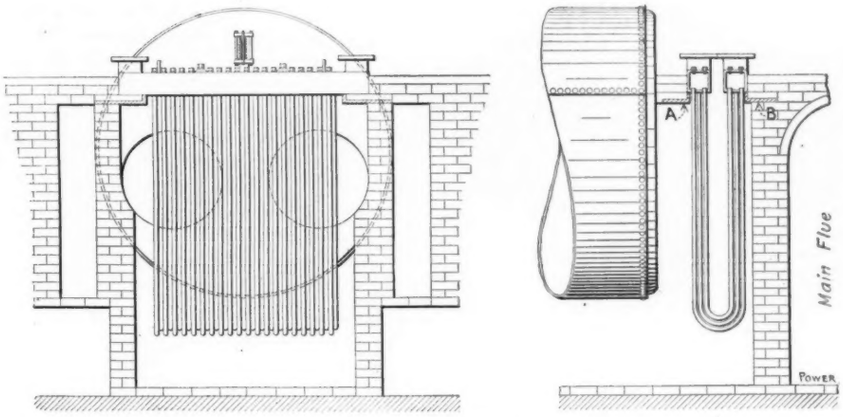


FIG. 3. MCPHAIL & SIMPSON SUPERHEATER

GALLOWAY'S SUPERHEATER

It would be difficult to present within reasonable compass a description of all the types of superheaters of modern construction which have been adopted in the power plants of Great Britain, inasmuch as developments in design are constantly proceeding in order to meet the requirements outlined in the opening paragraphs and also special difficulties as they arise. This portion of the subject must therefore be concluded by reference to three of the latest developments in design which each has as noteworthy features. The first is the new type of superheater which has been introduced by Galloways, Ltd., of Manchester.

The new type of superheater introduced last year by this firm is a distinct improvement upon the older type, and is shown in Fig. 5. It consists of two separate wrought-steel headers of circular form, flanged at one end and closed at the other. Each is bored for the tubes, and is further provided with a special opening opposite each nest of five tubes, these openings being fitted with special internal and external caps so arranged that each internal cap can be inserted into or removed from the superheater through its own or any other of the handhole openings. The tubes are U-shaped, 1½ inches bore, 1⅝ inches outside diameter, are of solid-drawn steel, and are expanded into the headers. The flanges are suitable for the attachment of 7-inch inlet and outlet pipes. The headers are rigidly stayed to each other by strong clips, and the superheater rests in a cast-iron tray or box of special section, suitably arranged for lining with insulated material, this tray being provided with a loose lid or hood, not shown, thus entirely inclosing the superheater. A 1½-inch open-type spring safety valve with easing gear is fitted in a suitable position, and a cast-iron plate is provided to carry the brickwork for the downtake, these plates being of tee section. The header boxes are well away from the direct path of the gases, and are raised above the brickwork with the special object of obtaining complete accessibility and good drainage.

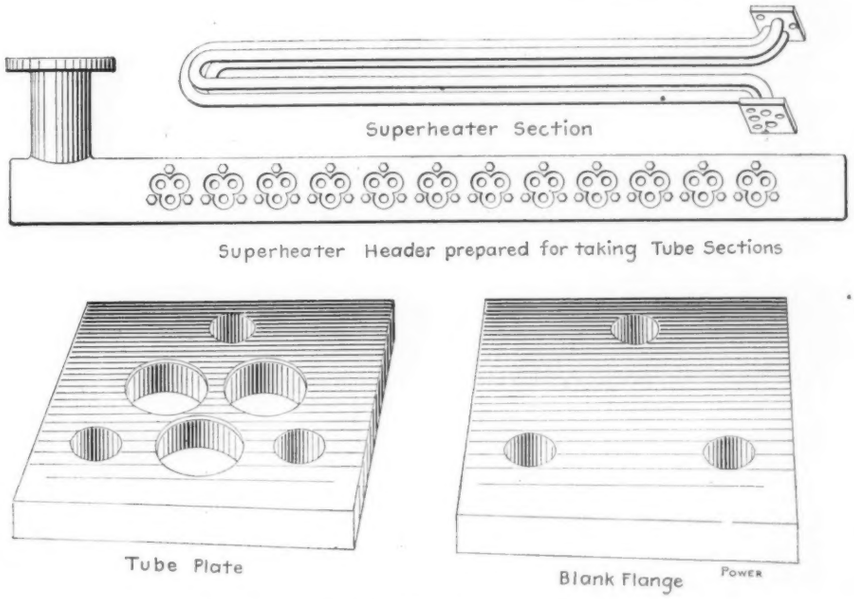


FIG. 4. PARTS OF GORDON SUPERHEATER

HERBERT SUPERHEATER

The second type which may be mentioned in this connection is that de-

signed by Charles Herbert and made by Tinker, Shenton & Co., Ltd., of Manchester. The distinguishing feature of this superheater, which is shown in elevation in Fig. 6, is accessibility. The circular form of the headers is the best form for withstanding steam pressure; also, the tubes, being expanded radially

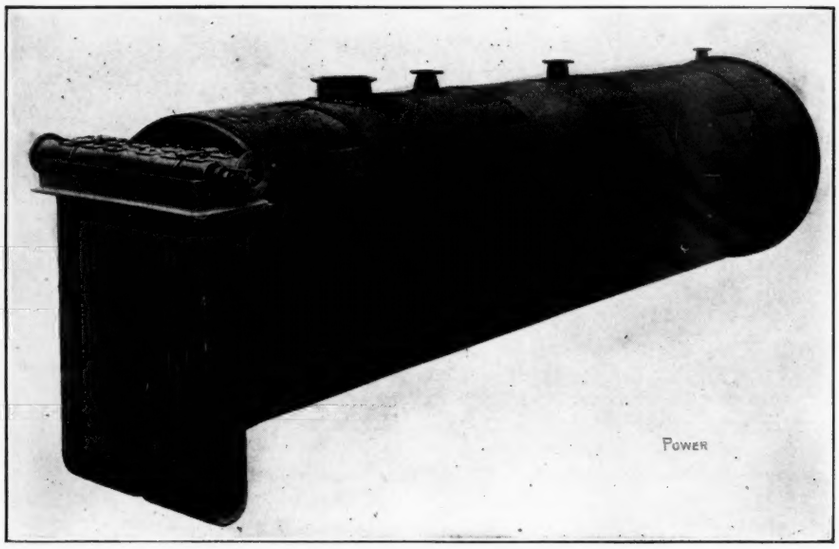


FIG. 5. GALLOWAY SUPERHEATER

to the headers, provide the desired facility of access to each individual tube for cleaning, inspection or replacement. The steam entering the internal header passes down the inner tubes and returns up the tubes with closed ends to the annular space contained in the outer header, and thus to the outlet branch. As there is

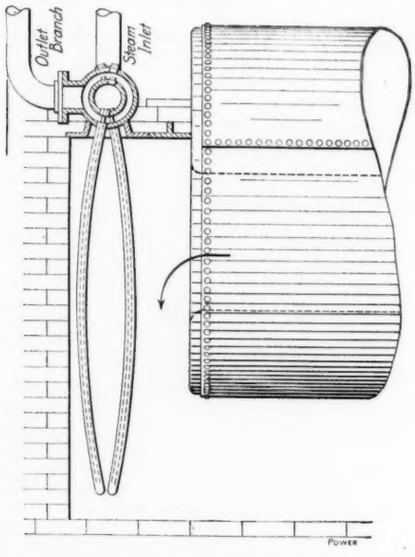


FIG. 6. HERBERT SUPERHEATER

much greater sectional area through the superheating tubes than through the main steam pipe, the steam passes slowly through the tubes and a uniform degree of superheat is obtained. The heating surface is proportioned to raise the temperature of the steam about 150 degrees Fahrenheit, a moderate degree of superheat which has now become the common practice, for large steam plants throughout Great Britain. The great advantages of the pendent form of tubes are: First, they are free to expand or contract with the varying temperatures, being held at one end only; second, the steam is split up into a thin film between the inner and the outer tubes and so passes the heating surfaces in the form most easily heated.

SIMPLEX SUPERHEATER

The remaining type of superheater differs essentially from those previously described in that the steam is dried by means of channels formed of steel boiler plating instead of tubes. This superheater, shown in Fig. 7, is made by the Simplex Superheater Co., Ltd., of London, and consists of a box-like receiver in which there are a number of diaphragm plates dividing the superheater into a series of compartments, spaces being left alternately at the top and the bottom of the diaphragms so that the steam shall take a zig-zag course and be well mixed during its passage through the superheater; by this means it is caused to flow for a considerable time over the hot plates. In the larger sizes the diaphragms consist of steel channels which are riveted to the side plates, these channels also acting as stays, whereas in the smaller sizes the diaphragms consist of steel plates carrying stout ferrules through which are passed the screwed and riveted stays binding the side plates together. Ample provision is made for examination and cleaning, there being an inspection hole at the top of every compartment excepting the end ones, which are provided with mud holes. As will be seen by reference to the illustration, the Simplex superheater (Lancashire boiler type) entirely dispenses with the flue-dividing wall, which is otherwise indispensable. Ordinarily without the dividing wall the

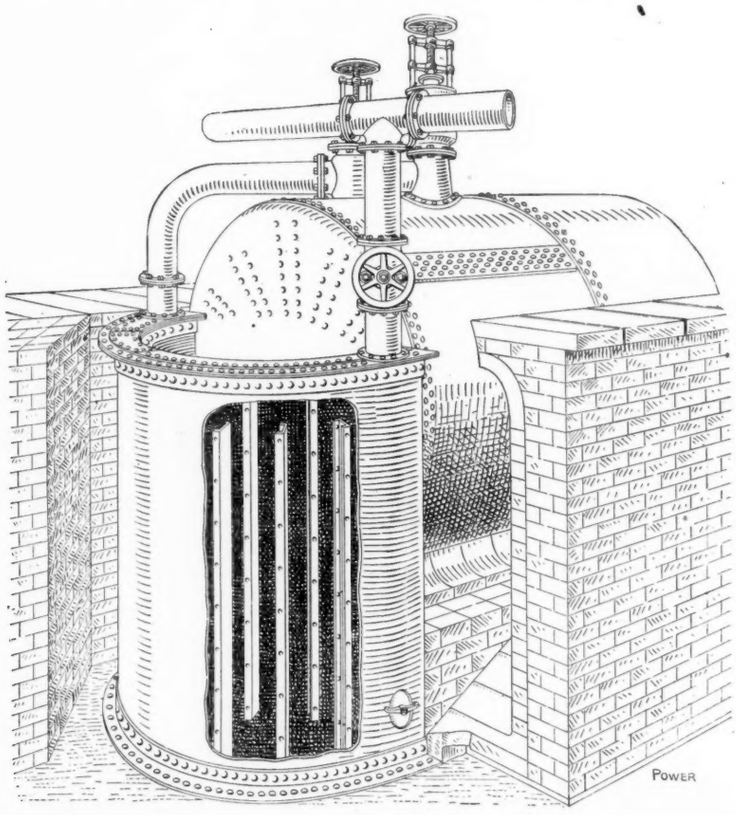


FIG. 7. SIMPLEX SUPERHEATER

hot gases would pass direct from the furnace into the main flue.

So far, the superheaters described have been discussed principally in relation to their place in the Lancashire boiler setting. The majority of them are equally adaptable to the water-tube type of boilers used in land practice, and, briefly, this aspect of the subject may be considered. In the Babcock & Wilcox boiler, for example, the type of superheater installed is so well known that it hardly needs any special description. It consists of a series of wrought-steel tubes bent to a U-shape and connected at both ends with manifolds, one of which receives the saturated steam from the boiler, the other collecting the steam after it has traversed the superheated tubes and delivering it to the valve placed above the boiler. The superheater is placed at the rear of the boiler above the boiler-heating tubes, where there is practically no deteriorating effect of the furnace gases and where the temperature is sufficiently high to raise the steam through 100 or 150 degrees Fahrenheit of superheat, or more if desired. On the Continent a superheat of 250 to 260 degrees Fahrenheit is often employed in connection with these boilers, by increasing the size of the superheater. Prevention against overheating during periods of steam raising is obtained by flooding the tubes with boiler water, using the superheater as part of the boiler-heating surface. The flooding arrangement consists of a connection with the water space of the boiler drum and two cocks. By the larger of these the water is allowed to enter the lower manifold, filling the superheater to the boiler-water level. Any steam formed in the superheater tubes is returned to the boiler drum through the collecting pipes which, under normal conditions, convey saturated steam to the upper manifold. Before opening the superheater stop valves and using saturated steam, the water is drained away from the manifolds by the flooding pipe and the smaller cock, a sight-glass being attached to the drain outlet in order to see when all the water has been drawn out of the superheater.

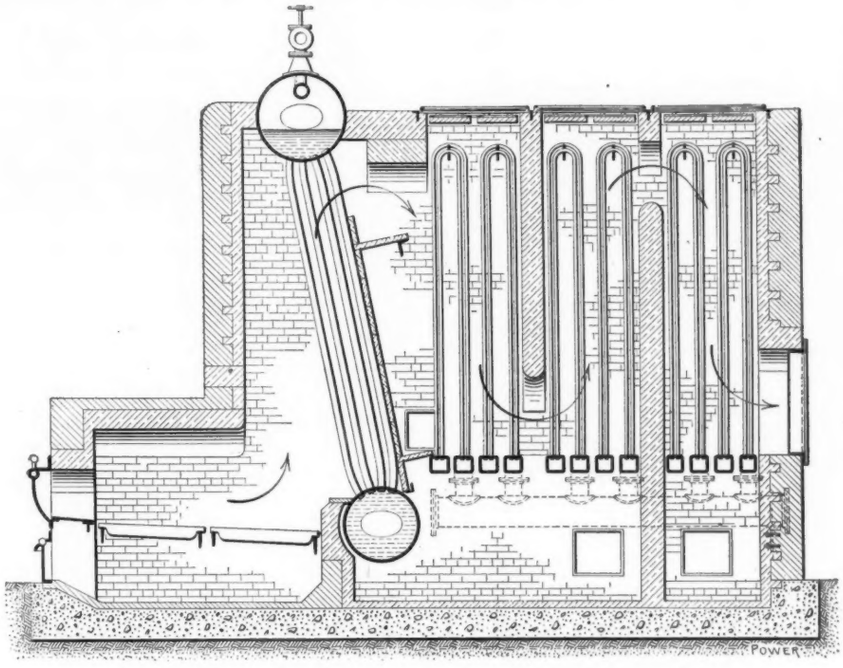


FIG. 8. STIRLING INDEPENDENTLY FIRED SUPERHEATER

INDEPENDENTLY FIRED SUPERHEATERS

It now remains to deal with the use of independently fired superheaters. These may be employed with any form of fuel, either coal, oil or gas. In addition to the uses in the power house, steam superheated in this way has been utilized in connection with the chemical industries, glycerin making, asphalt reduction, wood preservation, and evaporating, drying and heating installations of all descriptions, with a marked degree of success. Some interesting installations of independently fired superheaters are to be found in Great Britain in connection with large steel works. At the works of David Colville & Sons, Ltd., of Motherwell, Scotland, three sets of independently fired Watkinson superheaters, each dealing with 130,000 pounds of steam per hour, are used in connection with the steam supply to the rolling-mill engines. It has been found that when working with superheated steam the engines for rolling heavy plates get away much quicker, and a plate which with saturated steam occupied 4½ minutes could be rolled in 2½ minutes with superheated steam.

The ordinary design of independently fired superheater is very simple, the tubes being placed over a grate; and interposed between the grate and the tubes proper are brick baffles and cooling devices to keep the temperature of combustion at the lowest possible point.

STIRLING SUPERHEATER

In the Stirling independently fired superheater, shown in Fig. 8, a boiler element is introduced between the grate and the superheater proper. The temperature of the gases is lowered to about 1300 deg. F. before leaving the boiler section, so that overheating of the superheater tubes is thus avoided.

BABCOCK & WILCOX SUPERHEATER

Although, in the adoption of superheating, the Babcock & Wilcox Co. prefers to make the superheater a part of the boiler, there are certain cases in which it is necessary to use a separately fired superheater, such as where the arrangement of the boiler setting and steam pipes is such as will not admit of con-

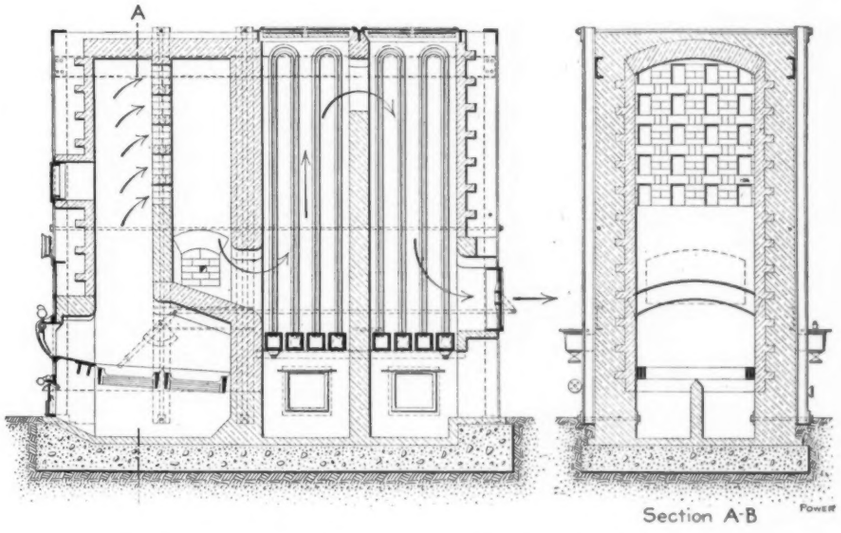


FIG. 9. BABCOCK & WILCOX INDEPENDENTLY FIRED SUPERHEATER

structing superheaters to form part of the boiler proper without stopping the works, or making costly alterations in the steam pipes, where it is desired for some particular purpose to superheat steam passed through an engine that has been exhausting at a pressure of 50 to 60 pounds, such as, for instance, in sugar refineries, and also for testing engines, etc. The Babcock & Wilcox patent independently fired superheater has a heating surface consisting entirely of extra-heavy vertical seamless tubes of 1½-inch outside diameter. The superheater has no screwed connections, all the tubes being expanded and bell-mouthed into holes drilled in the wrought-steel collectors. The steam enters the main connecting pipe and thence is distributed into the horizontal manifolds which connect with it. These manifolds are interconnected by double U-tubes, and with each other, in such a manner that a thorough circulation of the steam is obtained, the steam being eventually collected again in the collecting pipe. The furnace contains an ordinary grate and, in order to avoid the direct impingement of the flames on the tubes, it is practically constructed as a gas furnace. The gases enter a muffling chamber through a perforated wall, by which means an equal temperature can be obtained, whence they pass into the superheater chamber proper. After having passed through the superheater-tube chamber, around the brick flame baffles, the gases pass through the damper (which also regulates the combustion of the fuel) into the main flue. The superheater is fitted with a safety valve, a pressure gage, a dial thermometer and a drain valve to run off any condensed water that may have collected during the stoppage of the superheater. Fig. 9 shows one of these superheaters recently supplied to a large British power plant.

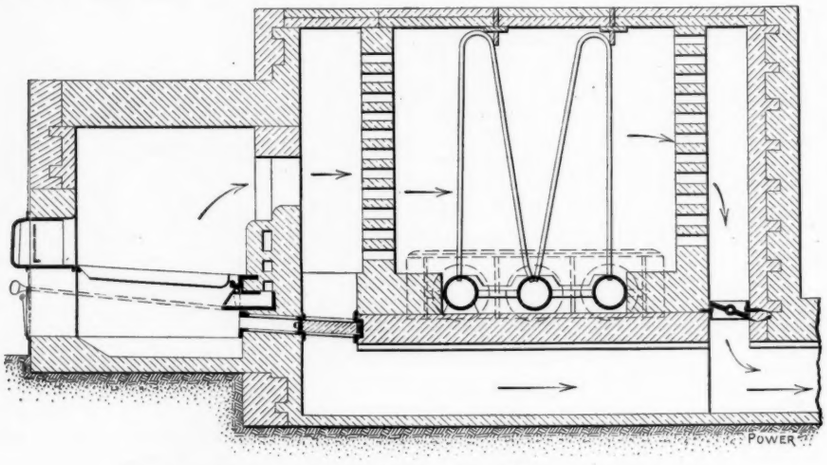


FIG. 10. WATKINSON INDEPENDENTLY FIRED SUPERHEATER

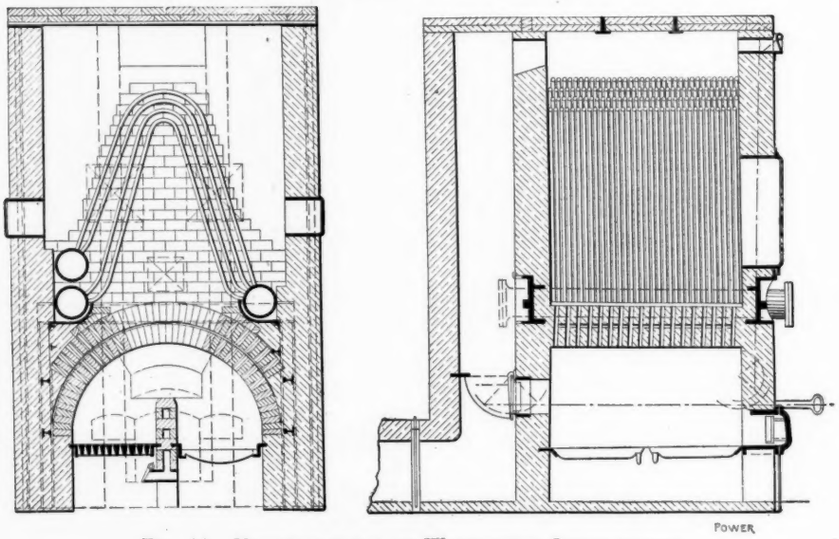


FIG. 11. MODIFIED FORM OF WATKINSON SUPERHEATER

WATKINSON SUPERHEATERS

One arrangement of the Watkinson independently fired type of superheater is shown in Fig. 10, the degree of superheat being regulated by the damper at the rear. A bypass damper and flue are also provided, so that during steam raising the products from the superheater furnace do not pass over the tubes of the superheater. The perforated firebrick walls through which the gases pass act as heat reservoirs and maintain the temperature of the gases when the furnace doors are open, while the brickwork takes in heat during the periods of most rapid combustion and thus acts as a regulator of the temperature of the gases supplied to the superheater.

Another successful arrangement of the same superheater is illustrated in Fig. 11. This type has the advantage in that it requires much less floor space than most other types. The furnace is placed below the superheater, the products of combustion rising through a perforated firebrick arch which acts as a gas distributor and heat regulator. In the case of these separately fired superheaters, the temperature of the products of combustion leaving the superheater is from 120 to 150 degrees Fahrenheit above the temperature of the steam entering the superheater, when the weight of the products of combustion is 24 pounds per pound of coal. The thermal efficiency of the superheater varies from 65 to 75 per cent.

A most important feature of this superheater is that all the tubes can be completely drained, and, owing to the tubes being almost vertical, there is not the same accumulation of soot and ash upon them as in the case of horizontal tubes.

Saving Fuel with Low Pressure Turbines

An example of operating advantages and actual saving in fuel consumption effected by the passing of steam from Corliss engines through low-pressure turbines is reported from a large Eastern chemical factory. The owners of this plant, which was being operated partly by shafting and belting from an old engine and partly by motors on current from two engine-driven electric units of 500 kw. capacity each, provided for an increase in capacity by installing two low-pressure turbines and direct-coupled generators also rated at 500 kw. each.

As the first result, the old engine was disconnected and the entire plant given over to motor drive. At present the two cross-compound engines and one low-pressure turbine are being operated on the day run and one engine and turbine on the night run.

Writing to an engineer who had assisted in laying out the enlarged plant, the owners stated that during the four days previous they had saved 55 tons of coal compared with the former consumption per unit of power. They had also begun the systematic keeping of a power log and felt that when they became better acquainted with the turbines they would be able to show still greater economy.

Wire Rope Splicing

By F. L. Johnson

Wire rope is susceptible of almost perfect splicing and the operation is so simple that it may be learned in an hour by any mechanic who is at all skillful in the use of ordinary tools. For all kinds of transmission rope the long splice is used and should not be less than 16 feet in length for ½-inch rope and increasing to 30 feet for the larger sizes.

Where the splicing must be done in position, rope blocks are used to draw the wire rope taut, as in Fig. 1, care being taken to make fast far enough from the ends to leave plenty of room for the splice and the men who make it. If possible, it is better to hold the rope taut, mark the splice on both ends, by securely winding with No. 20 annealed-iron wire, throw it off the sheaves and make the splice on the floor or staging, as may be most convenient.

The strands of both ends are unlaid, back to the points wound with wire, the hemp core cut off and the ends brought together with the strands interlaced, Fig. 2. Any strand, as *a*, is unlaid and closely followed by the corresponding strand 1 of the other end of the rope which is pressed closely into the groove

Fig. 1.

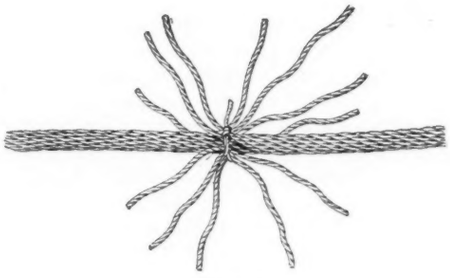


Fig. 2.

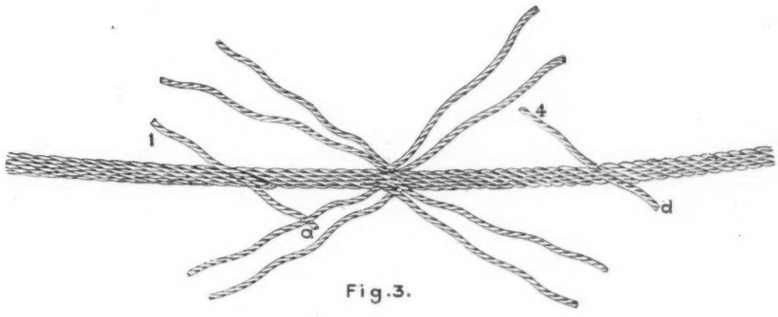


Fig. 3.

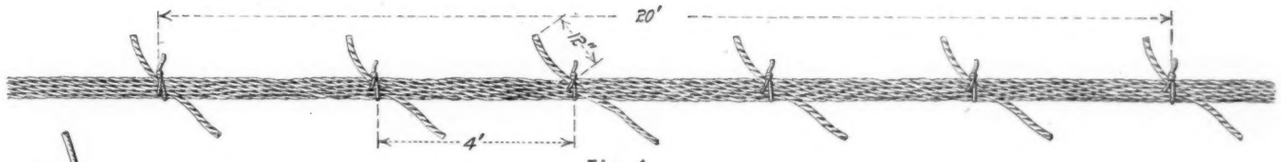


Fig. 4.

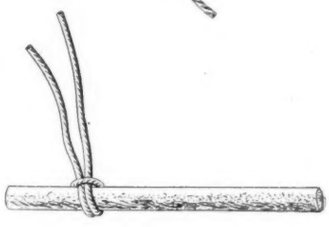


Fig. 5.

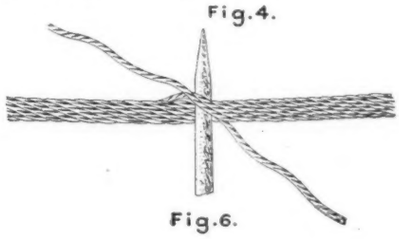


Fig. 6.

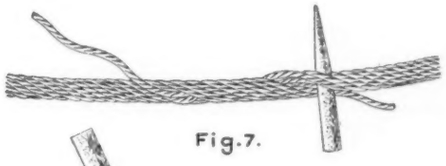


Fig. 7.

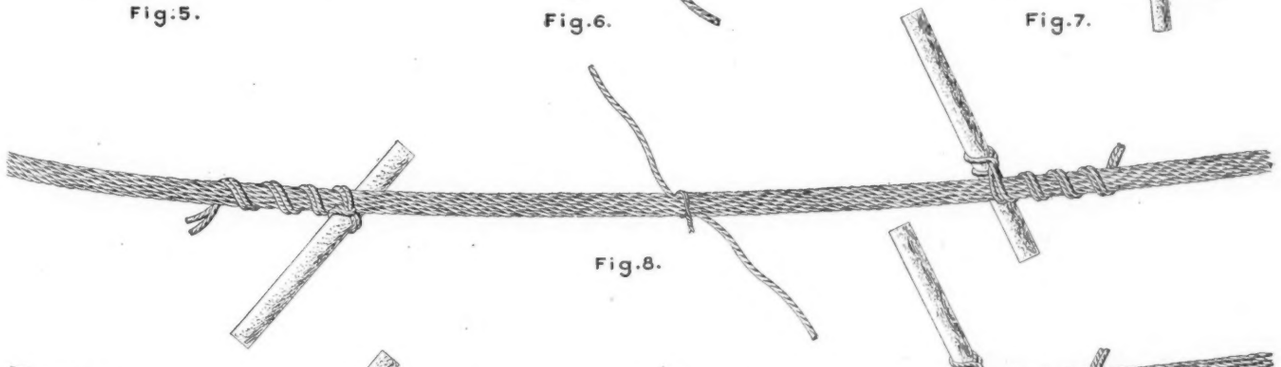


Fig. 8.

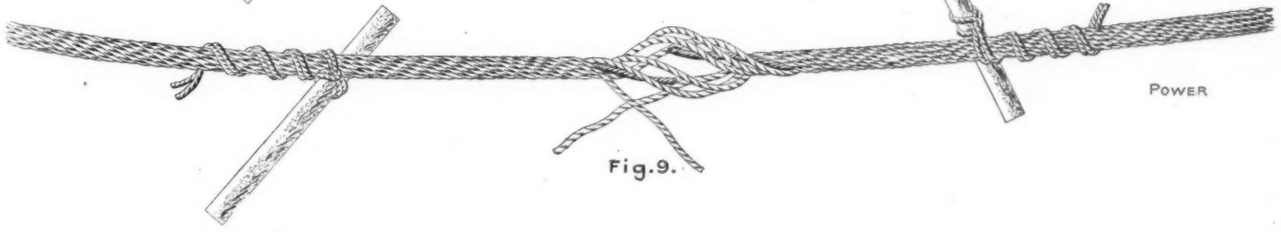


Fig. 9.

left by the unlaid strand. The unwinding of one strand and the inwinding of the other are continued until all but about 12 inches of strand 1 is inlaid, when *a* is cut off at the same length with a sharp chisel. See Fig. 3. Strands 4 and *d* are next treated in the same way and the process is repeated with each pair of strands until all are laid and cut as in Fig. 4.

Around each point where the free strands cross, a few turns of stout twine are made and the length of the splice is bent and worked in all directions until the tension in all the strands is equal and the rope as flexible there as elsewhere. If this is not done and there is more tension in some of the strands than in others when a stress is put on the rope, these strands will pull into the rope, making a bad-looking and weak splice.

Next, the open or free ends of the 12 strands are carefully trimmed and served or wound with fine wire, and two rope and stick clamps, Fig. 5, are secured to the rope, one on each side of an end crossing, as in Fig. 8, for the purpose of aiding in tucking the strand ends into the middle of the rope.

There are two ways of tucking in these ends. They are first straightened with a mallet. The long ends of the rope-clamp handles are twisted in opposite directions, separating the strands and exposing the hemp core, which is cut off and pulled out between the points to where the tucked-in strands will reach and the ends forced into the place formerly occupied by the core.

This is most easily done with the aid of a marine spike, which is passed over the strand which is to be tucked and under two strands of the rope, Fig. 6, and moved along the rope spirally following the lay and forcing the free end into the core space, Fig. 7.

In the other method the strands are more widely separated by untwisting the rope with the clamps, Fig. 9, slipping the free end in between the strands and correcting slight kinks by the use of a mallet.

The order in which the ends are tucked in is immaterial. Some operators prefer to tuck all the ends pointing in one direction before any of those pointing the opposite way, while others finish each pair of ends in series.

If the foregoing directions are intelligently followed the splice will be uniform with the rest of the rope, of nearly equal strength throughout, and after a few hours' use it will be almost impossible to detect the splice.

Any operator who is satisfied with what he is doing, says *Coal Age*, has reached his culminating point—he will progress no more. Too often we mistake movement for improvement. The measure of progress is not the ground passed over, but the gain in passing.

Connecting Rod Ends

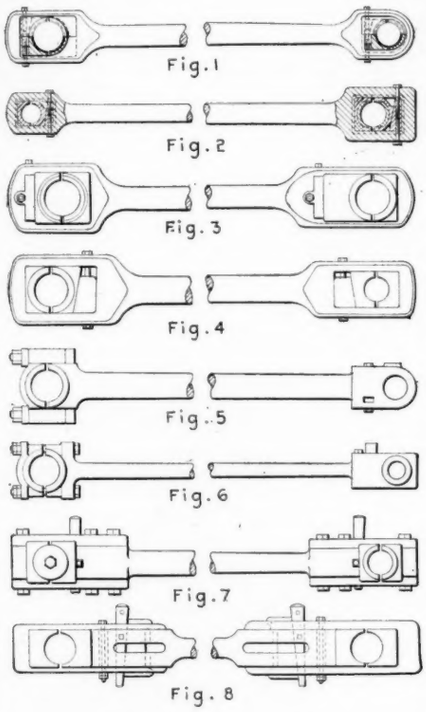
By J. A. Levy

It is interesting and instructive to notice the type of connecting-rod ends, used by the different engine builders, and the materials used in their construction.

Referring to Fig. 1, it will be seen that one wedge is between the pins and the other on the outside.

With this design, taking up the wear on one end lengthens the rod, while taking up on the other shortens it, and it will keep the rod of constant length, if the wear on the boxes is equal, but for the reason that the wear is greater on the crank end, allowance must be made. When the end box on the crosshead end is semicircular in form it is usually held in place by a setscrew in the end of the rod.

In Fig. 2 the wear is taken up by drawing the wedge up from the bottom, the exact opposite of Fig. 1. In Fig. 3 the wear is taken up by drawing the wedges in from the side.



The rod ends thus far considered have been designed with a view to keeping the rod of practically constant length, but the rod shown in Fig. 4 introduces a new feature. Both wedges are between the pins, and taking up the wear by drawing the wedges up has a tendency on both ends to lengthen the rod.

The rods shown in Figs. 5 and 6 are both for center-crank engines, the crank end consisting of two halves bolted together, with shims between the parts to allow for making adjustments and taking up the wear, until, when the limit of the shims is reached, it becomes necessary to rebabbitt the parts and replace the shims. The crosshead end of one of these rods is of the solid-end type with wedge adjustment, while that on the other engine is of the open-end type, with strap and key adjustment.

The rod shown in Fig. 7 is of the open-end, strap and key type, consisting of two steel straps bolted together, the bolts passing through the rod. The ends of the straps are held together by another bolt with a steel distance block between. Setscrews aid in holding the keys rigid. The rod shown in Fig. 8 presents some very interesting features. It is of the open-end type, with strap, gib-and-key adjustment. The strap is prevented from spreading by a bolt which passes through the rod. The bolt is a snug fit at both ends where it passes through the strap, but the hole through the rod is enlarged, as shown by the dotted lines, thus allowing for making adjustments. The strap is also tied near the ends by the V-shaped impressions in the ends of the gib, which engage the corresponding projections on the strap. The gib and key are only about one-half the thickness of the strap, which is slotted out to receive both. The portion of the gib inside the strap has no bearing on the rod, and the straight side of the key does not bear on the strap (see dotted lines), so that when driving the key the bearing is from the end of the rod against the butt box, on the one side, to the gib bearing on the V-shaped projection on the strap at the other side, the result being to pull the rod and butt box back toward the pin, and draw the strap on over the rod, thus drawing up the end box. This applies to both ends of the rod. Setscrews hold the keys from moving up, and thus working loose.

It will be well to get thoroughly familiar with the peculiarities of this type, because the location of shims in this rod end is a pet question with several of the examiners. Referring to Fig. 4, it was said that taking up the wear lengthened the rod, because both wedges were between the pins, but in Fig. 8, in spite of the fact that both keys are between the pins, the center-to-center distance between the pins is shortened by driving the keys, as will readily be seen by a study of the figure and accompanying explanations. Some builders use this same type of rod end on the crosshead end of some of their engines, taking advantage of this form of construction to produce a rod designed for constant length, compensating by using on the crank end a solid-end rod with a wedge adjustment inside the pin, which tends, when taking up the wear, to lengthen the rod.

There is little to be said regarding the comparative merits of the various types, as each represents a great number in use, giving satisfaction, and each has its advocates who are able to advance arguments in its favor.

Initial Cylinder Condensation

Abstract of paper read before the Institute of Engineers and Shipbuilders in Scotland by Prof. Mallanby, and the discussion following its presentation.

At a recent meeting of the Institution of Engineers and Shipbuilders in Scotland, considerable interest and much discussion were occasioned over a paper by Prof. Mellanby upon the initial condensation in steam-engine cylinders. The difference between the actual steam consumption and that indicated by an indicator diagram was popularly termed the "missing quantity."

Prof. Mellanby's contention was that the initial condensation in a steam cylinder at admission and the reëvaporation during expansion are not as great as is generally supposed. Admitting, however, that some does occur, he explained that the amount must depend altogether upon the temperature of the metal itself.

Assuming that the temperature changes in the steam engine cylinder follow approximately the simple harmonic law, the following formula was applied:

Heat absorbed per square foot per cycle $= \frac{2T}{1 + \frac{1}{N}}$ *B.t.u.*

where

T = Temperature range in degrees Fahrenheit;

N = Cycles per minute.

Citing some results obtained by Messrs. Callendar and Nicolson in temperature measurements upon an engine running at 73 r.p.m. in which the following were obtained,

	Max.	Min.	Mean	Range
Temperature of steam, degrees Fahrenheit.....	324	212	245	112
Temperature of cylinder metal, degrees Fahrenheit.....	304.4	297.6	301	6.8

Prof. Mellanby pointed out that the temperature range in the metal of 6.8 deg. applied to the foregoing formula would account for a very small amount of initially condensed steam.

Another formula for the heat absorbed by the cylinder walls (based upon Messrs. Callendar and Nicolson's work) was given.

In this the heat given out by the steam per square foot per second is taken as

$$0.74\ (T - \Theta)\ B.t.u.$$

where

T = Temperature of steam;

Θ = Temperature of metal.

The belief was expressed that a thermometer inserted in a hole in the cylinder would give the average temperature of the metal and that the indicator diagram would show the steam temperature, thus giving the quantities necessary for the solution of the formula. The following experimental data were given from measurements on the high-pressure cylinder of a compound engine.

	No Jackets	Jacketed
1. Steam used per hour, lb..	2184	1980
2. Indicated weight at cutoff, lb. per hour.....	1431	1470
3. Indicated weight at release, lb. per hour.....	1781	1760
4. Difference between actual and indicated weights, at cutoff, lb. per hour..	753	510
5. Difference between actual and indicated weights, at release, lb. per hour	403	220
6. Increase of indicated weight between cutoff and release, lb. per hour	350	290
7. Mean temperature of clearance surface, deg. F.	335	342
8. Mean temperature of steam, deg. F.....	284	282

These trials are to some extent illustrated by the accompanying diagram in which temperatures have been substituted for the usual pressure ordinates, these temperatures being plotted on the

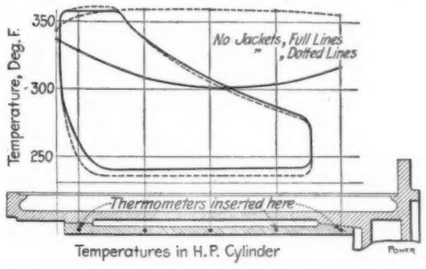


DIAGRAM SHOWING TEMPERATURE OF METAL AT DIFFERENT PARTS OF STROKE

assumption that the steam is always at saturation temperature during the stroke. On the same scale the average temperature of the metal along the cylinder is shown. The temperatures were obtained by thermometers inserted in the metal at the points marked by the circles. As would be expected, the jacketing has raised the temperature of the metal very considerably.

Line 4 in the foregoing tabulation shows that in the engine without jackets there was an apparent initial condensation of 753 lb. per hour, and that the application of the jackets reduced this to 510 lb. per hour. The apparent reevaporation between cutoff and release is shown in line 6 to be 350 lb. per hour for the unjacketed, and only 290 lb. per hour for the jacketed cylinder. That is to say, the hotter the walls the less readily will the water on them be evaporated. It is obvious that these figures cannot be explained on the initial condensation theory. The actual amounts of initial condensation, as estimated from the formula given previously, are, for the jacketed engine 114 lb. per hour, and for the unjacketed 80 lb. per hour. The remaining part of the difference between indicated and actual weights is to be attributed to valve leakage.

Also in the unjacketed trial the maximum temperature of the steam was 356.5 deg. F., and the mean temperature of the metal 335 deg. F. The greatest possible range of temperature in the metal could not be, therefore, more than

$$2\ (356.5 - 335) = 43 \text{ deg. F.}$$

Assuming this range, and using the formula for the heat absorbed during periodic temperature changes, it is found that under these conditions the steam initially condensed per hour would be 557 lb. The actual weight of steam to be accounted for was 753 lb. per hour, so that even if the smallness of the actual temperature range were not known from Callendar and Nicolson's work, and the excessive range given be assumed, the initial condensation theory apparently breaks down.

DISCUSSION

Prof. Mellanby's paper provoked much adverse criticism, some of which is herewith given:

R. M. Neilson was of the opinion that little reliance could be placed upon the first formula cited by Prof. Mellanby as it did not take into consideration either the velocity or the density of the steam.

Referring to the deductions from applying the second formula, Mr. Neilson pointed out that it would be necessary to measure accurately the temperature range in the metal. He criticized Prof. Mellanby's method of measuring the temperatures of the metal by inserting thermometers at the places indicated, and showed that this would register a mean temperature between that at the top of the hole and that at the bottom, instead of the temperature of the metal surface with which the steam comes in contact. To emphasize this point Mr. Neilson submitted some calculations showing that for any depth greater than 0.1 in. below the surface the temperature range is very small.

Commenting upon Prof. Mellanby's assertion (with reference to the experimental data given) that "the reevaporation in the case of the unjacketed cylinder is greater than in the case of the jacketed cylinder, which could not be the case if the missing quantity were accounted for by initial condensation," Mr. Neilson took just the opposite view, pointing

out that there is less steam initially condensed when the cylinder is jacketed because the cylinder walls are hot, hence there is very little condensation on the cylinder walls. Consequently the reevaporation is less because the condensation on the cylinder walls, being small, evaporates soon after cutoff and the evaporating surface is then limited to the surfaces of the piston and the steam ports.

Following Mr. Neilson, Mr. James Andrews took up the discussion. He asked where the thermometers were placed in Prof. Mellanby's engine. If the cylinders were horizontal and the thermometers were placed at the top of the cylinder, then he considered they would not indicate the temperature at the bottom of the cylinder. This was owing to the tendency of water to lie at the bottom of the cylinder. Referring to some tests made by himself as to the missing quantity in different engines, in which a tandem engine was compared with a cross-compound engine, he found that the missing quantity with the tandem engine was 49 per cent. in the high-pressure cylinder and 28 per cent. in the low-pressure cylinder, while with the cross-compound engine the missing quantity was 25 per cent. in the case of each cylinder. The steam when admitted to the high-pressure cylinder was dry in both cases. Mr. Andrews further contended that the time element had an important influence on the missing quantity. In one test which he carried out he found that, after the engine had been running eight hours, the missing quantity was 8 per cent. less in the high-pressure cylinder and 7 per cent. less in the low-pressure cylinder than was the case after the engine had been running only two hours. He also found that the speed at which the engine ran affected the missing quantity.

Mr. Andrews compared the results obtained by different experimenters as to valve leakage and remarked on the great disagreement between them. Referring to the wear on slide valves, he recalled a case in which 3/8 in. was worn off a locomotive slide valve in four months. With the valve pressed so hard against the face of the cylinder as to produce this wear he doubted if a film of water could exist between the valve and the cylinder, as is said to be the case by those who advance the valve-leakage theory.

Mr. C. A. Matthey confined his remarks to an incidental remark of Prof. Mellanby to the effect that during compression the steam was everywhere superheated, slightly in the main body, more near the walls, and most of all in a small pocket.

As pointed out by Mr. Matthey, steam remaining in the cylinder when the exhaust port closes is compressed to initial pressure either by the piston or partly by the piston and partly by the incoming steam. In many noncondensing engines such compression is effected entirely by the piston; and if, as Prof. Mellanby had stated, the steam and cylinder were dry at the commencement of compression, the steam was necessarily superheated during the whole of compression, and finally attained a temperature far higher than that of the initial saturated steam.

If dry saturated steam were expanded adiabatically, it would follow the law

$$P V^{1.0} = C$$

part of it being condensed. If this steam and water were compressed, it would follow the same law, and retrace the original expansion curve, till on arriving at the original pressure, its original volume and original temperature would be also established.

But if, after the steam was expanded to the lower limit of pressure, the water formed were removed, either by evaporation or by being swept out by some means, then upon compression the dry steam remaining would follow a different law, namely,

$$P V^{1.3} = C$$

and the temperature would rise much more rapidly than in the other case; the relation between pressure and temperature being

$$\frac{T}{t} = \left(\frac{P}{p}\right)^{\frac{0.3}{1.3}}$$

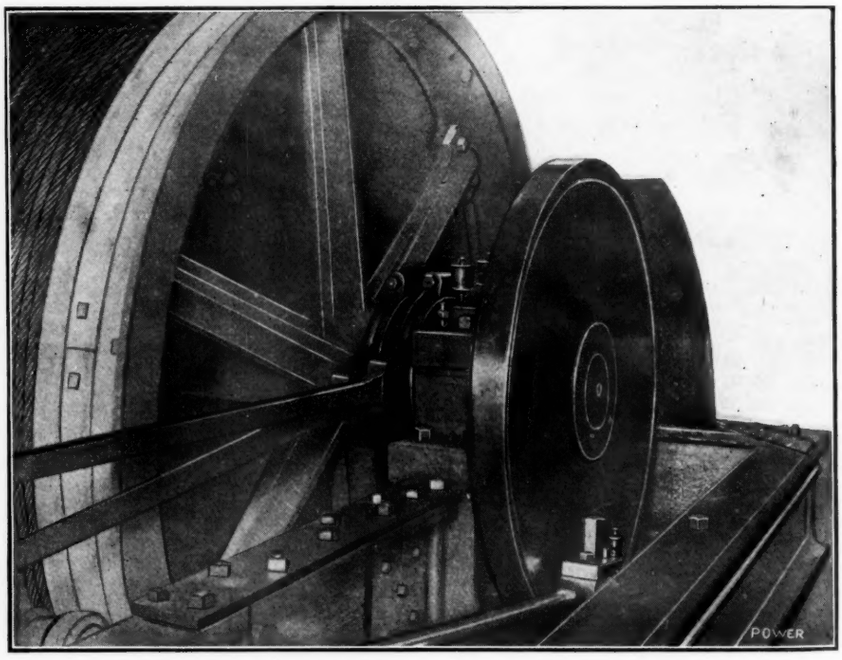
where T and t represent the upper and the lower absolute temperatures, and P and p the upper and lower absolute pressures.

Mr. Matthey cited an ordinary example from which, applying the formula, T was found to be over 600 deg. F. He then questioned if anyone of the "leakage" school had ever seen such temperatures recorded at the end of compression under these circumstances. Or, since it would not be reasonable to expect the full temperature, because, owing to the conductivity of the metal, the compression was not purely adiabatic, had they ever seen 500 degrees?

If they had not, it pointed to the presence of water, whose power of cooling when evaporating and absorbing latent heat was very great: but if they had, then through the greater part of compression the steam was hotter than the metal, and was giving up heat to it; consequently the steam next to the walls would be cooler than that more remote, and the steam in a small pocket would be coolest of all.

Light Engine Frame Fractured

The early types of hoisting engines were made extremely light, both in the bed and in crank-disk construction. The first frequently resulted in a fractured bed and the second in a cracked crank-disk. The latter was strengthened by shrinking a wrought-iron, or steel band on the rim of the disk. It is the regular practice of some companies, to thus guard against a possible fracture of the disk and its probable destructive results.



REINFORCING PLATES ON CRACKED ENGINE FRAME

In one instance, the frame cracked just inside of the pillow block and at the outside corner. The illustration shows how the bed was strengthened. On the

inside of the main pillow block a piece of 1-in. iron plate, 7 in. wide was bolted against the base of the bearing and secured to the frame by ten 1-in. bolts. A similar plate was bolted in like manner to the frame on the other side of the bearing.

The cracked corner was reinforced by a piece of ⅜ in. iron bolted in place, as shown. To act as a safeguard against further cracking of the bed a reinforcing piece was bolted to the inside of the frame directly over the crack.

Across each end of the frame cross-rods were placed through which 1 ¼ in. through-rods were run and the nuts screwed up tight. This engine has been used on slope work for years.

Heat Transmission

At the recent meeting of the American Society of Mechanical Engineers, George A. Orrok contributed to the work of the research committee the following résumé of present knowledge of the laws governing heat transmission, including the results of his own researches:

The present state of knowledge of the laws governing the transmission of heat through metallic tubes from gases and liquids to gases and liquids is that it takes place in at least three separate operations—the transfer from the warmer fluid to an initial surface of the tube; the heat passage through the tube wall from the warmer surface to the cooler surface of the tube, and the transfer from the secondary tube wall to the cooler fluid. This has been expressed by the general equation of Peclet:

$$\frac{1}{k}=\frac{1}{c}+\frac{1}{q}+\frac{1}{r}$$

where k is the coefficient of heat transmission.

The quantity q depends on the thermal conductivity of the tube which is now known quite accurately:

$$q=\frac{K_t}{D}$$

D = Thickness of tube;
K_t = A constant depending on the material.

r (following Osborne Reynolds) $=\frac{d_w V_w}{B}$

or, following Josse,

$$r=510\sqrt{V_w}$$

where

d_w = Density of the cooling fluid;
V_w = Velocity of cooling fluid;
B = A constant.

c (following Pickworth and Nicholson)

$$= 1.2\ V_s + 29{,}400\ d_s - 306$$

an empirical formula where V_s is the velocity of the hotter fluid and d_s its density.

The quantity q is always very large as compared to c or r; so much so that it can be neglected in practical problems; in other words, the heat-transferring capacity of metallic tubes is always largely in excess of the heat which can be brought in contact with the tube surface. For this reason it is much more convenient to use a simpler expression, such as

$$K=C\sqrt{V_w}$$

Fourier stated the law as follows:

$$dH = K\ S\ dz\ (T - t)$$

where

S = Surface;
z = Time;
T and t = Temperature.

When S and z are unity, this expression becomes:

$$H = K\ (T - t)$$

and $(T - t)$ corresponds to Θ_m in our modern expression. H equals N, the total heat transferred, and

$$N=K\Theta$$

$$N=C\sqrt{V_w}\Theta$$

which is the form commonly used today.

Determination of Heat Transfer

There are many practical problems connected with the determination of the laws of heat transfer. Some of the more important being:

The transfer from flue gas to water under the conditions existing in economizers. Here the transfer is of the order of 2 B.t.u. per square foot per hour per degree difference of temperature;

The transfer from flue gas to boiling water under boiler conditions (feed water heated to steam temperature). Here the transfer is of the order of 10 B.t.u. per square foot per hour per degree difference of temperature;

The transfer from flue gases to steam or air under superheater or air-heater conditions. This transfer is of the order of 4 B.t.u. per square foot per hour per degree difference of temperature;

The transfer from hot air to colder water under air-cooler conditions. This is of the order of 4 B.t.u. per square foot per hour per degree difference of temperature, and

The transfer from condensing steam to water under surface-condensing conditions. This is of the order of 1500 B.t.u. per square foot per hour per degree difference of temperature, when no air is present but falls off to from 500 to 600 B.t.u. when an ordinary amount of air is present.

There seems to be an essential difference in the action when a condensible gas or vapor is the high-temperature fluid. Here the vapor gives up its latent heat to the colder tube and contracts enormously in condensing, causing an exceedingly rapid flow normal to the tube. It may be that an analogous action takes place when the colder tube is exposed to the "bombardment" of radiant heat as in the case of boiler tubes exposed to the rays from white-hot surfaces of fuel or brickwork.

Prof. Bone, in his lecture before the Royal Society last year, stated that he had obtained in an experimental boiler an evaporation as high as 41 lb. of water per square foot of surface which corresponds to approximately 25 B.t.u. per square foot per hour per degree difference. This was due to the radiant heat condition.

Probably the best exposition of the problem where a permanent gas is the hotter fluid is given in Prof. Dalby's report to the Institution of Mechanical Engineers (Oct. 29, 1909), and his conclusions (summed up on pages 25 to 28) show the exceedingly difficult nature of the problem and the necessarily costly means which must be used for its complete solution. The main factor is the determination of the temperature gradients in all parts of the boiler. That this is also true of condenser conditions may be seen from the work of Smith and Josse and the author's paper before this society last year.

"Mass Flow" Theory

The "mass flow" theory of Osborne Reynolds and Jordan seems to be another form of stating the fact that where more heat is present more is transmitted and this is known to be true up to the limit of heat transfer. Kreisinger and Ray have investigated this problem with an experimental boiler using air heated electrically as the hotter fluid, and their results have been widely quoted. The work of Perry, developed by Breckenridge in Bulletin 325 of the Geological Survey, is also of great value in this connection.

Summary

Summarizing, the lines of work which will be most fruitful are as follows:

1. A final determination of the radiant-heat law (Stefan's law) with a separation from conduction and convection problems. It is probable that Stefan's law is nearly correct, but does the black-body condition exist, and between what ranges of temperature? Bone's experiments seem to show that it may exist at temperatures below red heat. (See Bulletin No. 8, Department of Mines.)

It is known that in boiler conditions radiation is much more efficient than either conduction or convection. How much of the heat supply can be developed as radiant energy? Both Nicholson and Bone claim that the boiler of the future will depend largely on radiation rather than conduction.

2. More study of the phenomena of heat transfer in the absence of radiant energy, if this is possible. What is the effect of dust and soot in the gases? Do the dust particles act as black bodies and give out radiant energy? It has

been stated that 98 per cent. of the temperature drop took place in the passage of the heat from the gas to the tube surface. Is this statement correct and, if so, can the "gas film" be removed or made a better conductor?

3. Determination of the temperature gradient under a variety of practical conditions, and with full-size apparatus. Does the "gas film" give more trouble when inside a fire tube with axial flow of gases or when outside a water tube with a flow across the surface?

4. A determination of the law of temperature rise in the water flowing in a condenser tube. The tube should be long and the thermometers numerous.

5. A repetition of Smith's experiments with the addition of known amounts of air and with the use of very sensitive thermometers. This series should include all commercial vacuums, and the lower end of the steam table should be recalculated with much smaller intervals for use in interpreting the results.

6. The author has used the expressions "radiant heat," "latent heat," etc. Sensible heat is defined as molecular motion, radiant heat has been defined as "ether waves." When latent heat is set free as in a condenser, is it molecular or ethereal in its constitution? In chemistry, there is a state known as the nascent state existing when an element is set free from combination. Does an analogous action take place when heat is set free from the latent state?

Some of these questions should be perhaps answered by the physicist rather than the engineer, but in the author's opinion they are true engineering problems and must be studied through their applications if a complete, reasonable and satisfying theory is to be obtained.

Boiler Explosions in England

By William H. Booth

The treatment of boiler explosions in England has often been described as locking the stable door after the steed has left it. To inquire into a boiler explosion after the event is, on the face of it, inferior to the German governmental attempt to prevent explosions. Moreover, to hold a solemn inquiry into such happenings as the fusing of a fusible plug—which it is said has been at least once classed as an explosion—savors of the ridiculous. In England there is no governmental or municipal control of steam boilers. There is a law that every boiler must be periodically inspected by a competent person, but there is no definition of the term, competent person.

In Germany the government does directly interfere to prevent explosions. In England a boiler owner may employ anyone he likes to do his inspecting, though he usually places his boilers in the hands of the boiler-insurance companies and leaves to them the selection of their own inspectors. Even then steam users are apt to regard the report as a certificate of safety and totally to neglect for years its recommendations.

Now what happens in this very English "muddling through"? First, our boilers are considerably safer than German boilers, a fact curious perhaps but true. And the inquiry after the fact has undoubtedly much to do with it.

Inquiry after the Fact

Suppose an explosion takes place: There is an inquiry. Wigged barristers are then asking questions and bullying witnesses, as is the barrister's silly habit. Hundreds of silly questions are put to witnesses. The last inquiry I attended was concerning an explosion at Greenwich. I remember that a witness who was obviously speaking the truth, answered a question in a way all engineers present understood. The barrister, who perhaps had never seen a boiler in his life, was extremely rude to him, for he could not understand the answer and treated the witness as a rogue.

Somehow, a certain amount of truth is brought out—perhaps about a fourth as much as an engineer would get in a tenth of the time. Then comes the finding of the court. In the course of events I have seen a competent person charged or fined because he had no status to act as a competent person in boiler inspection. Possibly he was only a boiler-setting man or brick mason. I have seen an owner fined for employing the wrong sort of "competent person." Or he has been fined for neglecting to follow the recommendations of the boiler-insurance company; and again a boiler-insurance company has been censured and fined for continuing to insure boilers in face of the owners' continued neglect of its recommendations. The court sees the recommendation. If the recommendation is right and proper, it ought to have been insisted upon, they rightly argue. Chief engineers who have been electrical experts have got into trouble for assuming responsibility and therefore, by inference, knowledge of boilers they could not substantiate when called as witnesses.

Beneficial Effect of Inquiries

Costly as are these inquiries into explosions, they undoubtedly have a salutary effect on everybody concerned with boilers, for they lead to men putting onto paper their opinions as to the danger of a given boiler and thus bring to a focus on the proprietor the fact that it was his duty to remedy the danger. In a case under my own knowledge an engineer knew that the owner would say, "I trusted to my engineer." Yet that owner would not follow advice which, in daily contact, was passed verbally. So the engineer wrote a letter, copied it and sent it by registered post to the owner and thus effectively put the onus of a possible accident where it belonged.

The Board of Trade merely appoints a commission of inquiry, and if England's immunity from boiler explosions is greater than that of other countries, some of that immunity is possibly due to the greater freedom enjoyed by the owner to do as he likes, subject to an inquiry as to whether in the exercise of that freedom he has encroached on the freedom of others who are entitled to walk past a steam boiler in safety. It is, of course, open to the commission of inquiry to find that some person is guilty of manslaughter and in such an event the punishment after further trial might be severe.

Risk of Trial for Manslaughter

The risk of a trial for manslaughter must be faced by every boiler owner who neglects a serious report by a competent person. If the neglect continues long enough the onus may be shifted to the competent person, if such be an insurance company, for its neglect to treat the owner's neglect seriously; it may be urged by the owner in palliation of his own neglect, for he could well say, "If so serious, why did the company not refuse longer to insure the boiler?" If an owner employs an engineer who is fully empowered to do the right thing, yet neglects to do so, the owner would be absolved from blame.

The customary mode of fining consists in ordering a man to pay a certain sum toward the cost of the inquiry. It is not necessary that anyone should be either killed or injured; that an explosion has taken place is sufficient for a notification to be made. Little affairs are reported in a small way; more serious affairs are given a full-powered inquiry.

The only satisfactory, rational excuse for our method is on the principle of the proof of the pudding being in the eating thereof, for England does stand an easy first in the matter of boiler safety and minimum loss of life.

Used Gunpowder to Clean Flues

As the result of attempting to use a pint of gunpowder to clean the flues of a boiler connected to the hoisting engine used by the iron workers on the new Petroleum bridge at Oil City, Penn., the engineer is in the city hospital with his face and neck covered with burns and the possibility that the sight of one eye has been destroyed. He threw the gunpowder over the fire, expecting that the soot in the flues would be "exploded" out. The result immediately following such a rash experiment may be readily imagined.

Electrical Department

Conducted to be of service to the men in charge of electrical equipment in the power house

Rewinding an Induction Motor Stator*

By R. H. Fenkhausen

Number of Coil Elements

Most induction motors contain coils of two or even three "elements," and as the form described in the preceding article is only adapted to single-element coils, it will be necessary to wind the elements

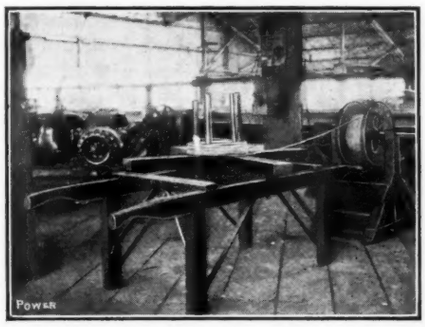


Fig. 11. Transferring to a Reel

separately. Forms can be made on which two- and three-element coils may be wound, but they are too intricate for industrial repair service, and have no advantage where the elements are connected in multiple. Where the elements are connected in series, the use of a two-element form obviates the use of internal soldered joints in the coil. This is only a slight advantage, as trouble from internal joints is practically unknown where they are properly located and well made.

As the designations "right" and "left" as applied to coils are purely arbitrary ones, the following rule will be useful: *Place the coil so that the terminals are toward the obserer. If the "high" side of the coil is on the right, the coil is "right-handed."* By this rule, the coils shown in Fig. 14 are left-hand coils, because the high side of the coil is at the left.

It has become the standard practice of most motor builders to bring all the coil terminals out at one side of the motor, "right-hand" coils alone being commonly used. This allows a standard motor winding to be reconnected for several voltages, both two-phase and three-phase, and even for different speeds, upon removing only one end bell, without the rotor being disturbed. Changing the number of poles, of course, changes the ratio of coil pitch to full pitch, but, as explained in discussing fractional pitch, considerable latitude exists in this respect.

When a two-phase motor with standardized coils is to be wholly or even half rewound, the new coils may be wound so that the connections of the two phases are brought out at opposite ends of the motor, which greatly facilitates the tracing of connections when trouble must be located quickly.

Preparing the Magnet Wire

As the magnet wire necessary to make a set of coils is usually only a small part of a standard reel, this wire will be received from the supply house in the shape of an open bundle or so called "coil," in

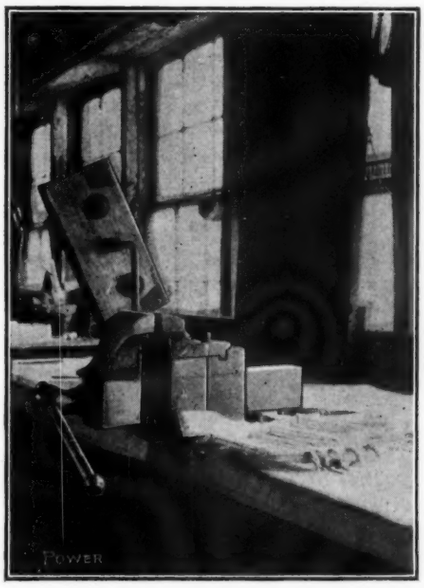


Fig. 12. Support for Coil Form

which shape it is utterly useless for coil-winding purposes, owing to the liability of kinks and tangles forming while it is being used. A lineman's wire barrow with adjustable "stakes," or some equivalent device, may be used to hold the bundle of wire, but it will not give satisfaction because the tension required to turn the reel will pull the outer wires down between the inner layers of the bundle, from which they will pull out by jerks during the winding process. As every jerk puts a kink in the wire which must subsequently be straightened out, it is evident that a considerable loss of time will result.

Fig. 11 illustrates one method of disposing of this annoyance. The bundle of wire is placed on a wire barrow and the free end attached to an empty magnet-wire reel onto which the wire is transferred by turning the reel. The half-round groove in one flange of the reel is to accommodate a small leather brake strap fastened to the reel stand at one end and passing over the grooved flange. By attaching the proper weight to the free end, any winding tension desired may be obtained.

Supporting the Coil Form

Even if a lathe be available, the wisdom of using it to rotate the form is questionable, unless the winder's hands be left free by the application of some method of foot control. It usually takes a beginner much longer to shape the twisted ends of the coil than it does to shape the straight sides, so that even if a foot control is improvised, the uniform speed of the lathe will necessitate winding the whole coil at the slow speed required for the end connections, and the

Fig. 13. Winding an Element

varied character of industrial repair work seldom gives the winder an opportunity to become skilled in any one operation.

Fig. 12 shows a simple bent rod used as a mandrel by clamping the vertical portion in a vise at a height sufficient to clear the corners of the form during rotation. The form must be rotated by a boy, and it will be found that by watch-

*The first half of this article appeared in the issue of Jan. 9.

ing the winder the boy can accommodate the position of the form to the wire very easily. The time usually lost in clamping and unclamping the form in the lathe is saved and with a few hours' practice a set of 144 coil elements should be

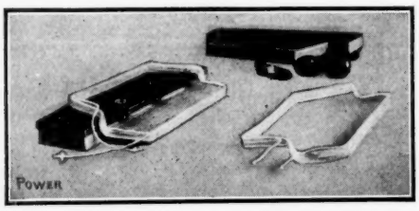


FIG. 14. READY FOR REMOVAL

wound by a man and helper in two eight-hour days.

WINDING THE COIL

A piece of soft flannel should be wrapped around the magnet wire to protect the winder's hands and the wire firmly gripped by the fiber clamp, care being used that an end is left beyond the clamp long enough to form the coil terminal. The form must then be rotated away from the winder by the helper until the required number of turns is in place, after which it should be slipped off the mandrel and the coil gently hammered into shape. While the coil is being shaped by the winder, the helper should prepare four little "hairpins" of No. 22 annealed copper wire which are to be slipped over the coil by way of the saw slots in the form and twisted up. These copper wire ties serve to hold the coil in shape after it is taken from the form, and care must be used not to twist them up tightly enough to damage the cotton covering on the wire. Fig. 13 shows the operation of winding and illustrates the formation of the "twist" by the winder's thumb. After the tie wires are in place the fiber clamp may be released, the form taken apart and the coil removed. Fig. 14 shows an open form with a coil ready to be removed. The tie wires are also

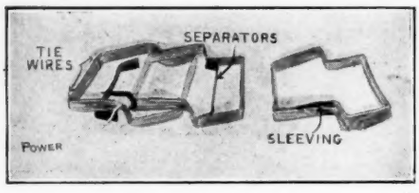


FIG. 15. NESTING TWO-ELEMENT COILS

clearly shown, and to the right a similar coil with the terminals shaped.

CONNECTIONS BETWEEN LAYERS

After the full set of coil elements and a few spares are completed, the next operation is the grouping of the elements into complete coils. Two stages of this operation are illustrated in Fig. 15. If the elements are to be connected in multiple, all four coil terminals will be carried outside the taping, but if a series connection is required an internal soldered joint should be made. It is possible to make the series connections outside the coil, but owing to space limitations it is not usually advisable, because it doubles the number of stub-end connections in the winding.

The choice between series and parallel coil elements often rests with the winder, as in the case of motor windings with interchangeable connections for 200 and 400 volts, as described in a previous article (see also the accompanying table of winding data). Take, for example, a motor having coils wound with two coil elements in series and the pole groups paralleled for 200-volt operation. If the winder so desires, the elements of each coil may be paralleled and the pole

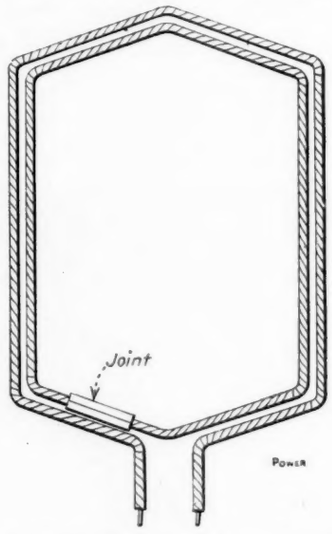


FIG. 16. RESULT OF WRONG ELEMENT CONNECTION

groups reconnected in series. This method will save considerable work and will do away with soldered joints inside the taping of the coil, but it should never be employed where there is any probability that the motor will be required to operate on the higher voltage. Before nesting the elements, thin fishpaper separators, long enough to extend well around the bends in the coil, should be inserted between the two parts of the coil, as indicated in Fig. 15. These give additional stiffness to the coil, preventing its collapse during the taping operation. The copper ties must be replaced with new ones encircling both elements and the coil terminals carefully bent into place. If series connections are to be employed, one terminal of each element must be cut off and the two connected. Before soldering the joint the outside terminals of the coil should be tried in series with a test lamp to insure that the series connections have been properly made. It is very easy to mistake the ends of the two elements, resulting in the condition represented in Fig. 16, and if the test lamp lights, indicating a closed circuit while the connection between elements is still open, the connections are wrong and only one element will be in circuit, the other being short-circuited.

If the coil tests all right, a short piece of sleeving should be slipped over one end of the joint and pushed back out of the way temporarily. Both terminals of the coil, as well as both ends of the series connection, should be carefully tinned with a nonacid flux, and a sleeve connector made of thin leaf copper soldered onto the joint. The short piece of sleeving may then be pulled snugly over the soldered joint and the coil laid aside for dipping, as shown at the right in Fig. 15.

The reason for beginning the coil on a certain side of the form can now be explained by aid of Fig. 17. The four possible locations of the joint are shown at *a, b, c* and *d*; *a* and *d* are both bad because the sleeve connector will come between the upper and lower groups of end connections, where it is liable to be forced through the taping by accidental blows, which tend to drive the end connections together. Location at *c* is bad because the sleeve connector causes a slight lump under the taping of the coil, which is very apt to be abraded while the rotor is being inserted. Location at *b* will bring all the connectors on the outside of the winding where they are out of harm's way, but will be plainly visible in case of trouble at the joint. A few experiments will show that in order to bring the joint at *b*, and still have a coil of the unsymmetrical type properly fitted in the slots, it will be necessary to place the starting clamp on the form exactly as described before.

DIPPING THE COILS

As soon as all the coil elements are nested they should be dipped in some form of insulating varnish, which will improve the insulation and cement the turns of the coil together. A baking varnish should be used if an oven is available,

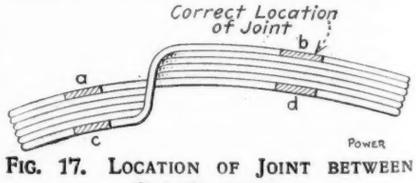


FIG. 17. LOCATION OF JOINT BETWEEN COIL ELEMENTS

but an air-drying varnish will give excellent results if the oven cannot be procured. The varnish selected must be nonsoluble in oil, nonhydroscopic, and preferably light in color, to facilitate the detection of partly charred insulation. Shellac forms an excellent dip, aside from its tendency to become brittle when thoroughly dry. A varnish which will remain semi-flexible is, of course, to be

preferred, other things being equal, but whatever varnish is selected, it should be thinned down so that it will readily penetrate between the various turns of the coil.

After the coils are removed from the dipping tank they should be hung up by one end and allowed to drain for a few minutes, after which they should be reversed, the bottom of the suspended coil becoming the top. This procedure insures a more even distribution of the varnish and allows the surplus which naturally flows to the bottom of the coil to flow back over the thin upper places in the coating. Besides the additional stiffness and improved insulation resulting from dipping the coils, it will also be found that dipped coils will run cooler than coils not so treated. This is probably due to the better heat conductivity of the varnish, which fills up all the spaces between the turns of the coil and allows the heat to be readily conducted to the surface and radiated.

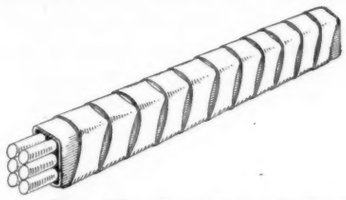


FIG. 18. DEFECTIVE TAPING

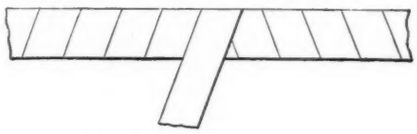


FIG. 19. REVERSE TAPING

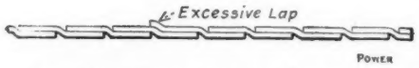


FIG. 20. EFFECT OF TOO MUCH LAP

TAPING

After the coils are thoroughly dry they should be taped. The thickness and number of layers of tape used will, of course, depend on the operating voltage of the machine, the space available in the slot and the amount of slot insulation to be used. Enough insulation must be used on the coil to make it drive lightly into the slot, not tightly enough, however, to cause the coil to bend when it is removed by lifting both ends of the straight portion. If the coil is too tight it will be damaged by driving it into place; if too loose, it will vibrate when the motor is in service, and the insulation is apt to be destroyed. If two layers of taping leave the coil too loose and the layers make it too tight, the proper fit may be secured by the insertion of a thin paper filler between the fishpaper and treated cloth cells in the slots.

If the end connections are shaped so that there is a small air space between them when in place on the stator, one layer of cotton tape lapped one-half will give sufficient mechanical protection and the air space between the coils renders additional insulation unnecessary. If the shape of the end connections is such that adjacent coils fit snugly together, extra insulation will be required on the end coil of each group where the voltage exceeds 250. The voltage between adjacent coils of a group is only a small fraction of the motor voltage, but the end coils of each group are in contact with coils connected to the opposite phase and are subjected to the full differences of potential between phases. The additional insulation on these end coils is most readily applied in the shape of a layer of treated cloth tape, bound around the part of the coil lying outside of the slots, underneath the outside taping. For voltages exceeding 1100, the potential difference between coils is great enough to make double taping advisable on all coils.

The tape commonly used for the outer covering of coils is from ½ to ¾ in. wide and is composed of muslin webbing. The tape should be of open weave to allow the insulating varnish to penetrate readily into the interior of the coil, and should be cut on the bias for use on the twists and corners of the end connections, and cut straight for use on the straight portions (sides) of the coil. One kind of tape may be used for the entire coil when the size of the coil is small, but the results will not be as satisfactory. If straight-cut tape is used, it will be found that it is practically impossible to make a neat job of the end connections, and if bias-cut tape is used altogether, it will either lap over on the corners of the coil or stand open on the sides, due to the stretching of the weave, as shown in Fig. 18.

There are two ways of winding the required number of layers of tape on the coil. The first is to wind each layer separately and without lap, reversing the direction at the end of each layer, as shown in Fig. 19. The other method is to lap each layer the required amount; for instance, a one-half lap gives two layers, and a two-thirds lap, three layers.

Great care must be used when lapping the tape, that the required lap is not exceeded, because the thickest part of the coil determines the fit in the slot, and even a $\frac{1}{32}$-in. lap over the necessary amount will give to the coil the effective thickness of an additional layer of tape, as shown exaggeratedly in Fig. 20.

SHAPING THE COILS

After the coils are all taped, the end connections must be bent to conform to the curve of the stator bore, as shown in Fig. 21. The coils are wound with the sides parallel and as the slots are all radial, they must be bent at the proper angle to lie in the slots. It will be found that the proper angle between the straight parts of the coil will result naturally from the curving of the end connections shown in Fig. 17, which may be given to the coil by bending over the thumbs of the two hands, except with very large coils, which require a press. After the coils are shaped they should again be dipped in insulating varnish, and when thoroughly dry the straight sides, which will lie on the slots, must be pressed between a pair of fiber blocks, clamped to the jaws of a vise. These blocks should be grooved to receive the coil, as shown in Fig. 22, the grooves being each one-half as deep as the width of the slot with all the insulating cells in place. Considerable pressure may be applied to the coil without causing any damage, because the fishpaper separators placed between the layers of the coil prevent the turns of one layer from being forced between the turns of the other layer, and coils having absolutely uniform thickness will result and materially aid their insertion into the slots.

MAKING THE CELLS

Most of the slot insulation ordinarily employed is for mechanical strength, and a comparatively small amount would suffice were it not for the liability of damage due to high laminations, etc. Most of the space available for insulation is therefore occupied by a cell of very tough fibrous paper about 10 mils thick, known to the trade as leatheroid or fishpaper, and having a breakdown resistance sufficient to withstand almost 2000 volts. The cells of this material should extend about ¼ in. beyond the iron and should be a trifle below the top of the teeth when in place.

An additional factor of safety is usually given to the insulation by inserting a cell of varnished cloth or treated cambric between the leatheroid cell and the coil. This material has a breakdown voltage of 1000 volts per mil, and when used in places protected from mechanical injury, such as inside cells, renders a motor practically immune from breakdowns due to faulty insulation.

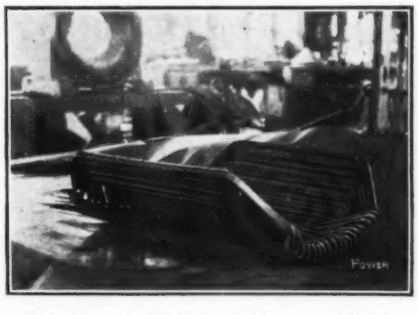


FIG. 21. A SHAPED GROUP OF COILS

The varnished cloth cell should be cut the same width as the fishpaper cell, but must be left long enough to guide the coil into the slot and protect it from injurious contact with the corners and

edges of the slot. Fig. 23 shows a stator with part of the cells in place and illustrates the method of inserting the cloth inner cells.

A cell-cutter similar to the one described in the article on rotor repairs should be used to cut the cells, and as the treated cloth is quite expensive, it will pay to devote a little time to finding out how to cut the cells with the least waste of material.

Inserting the Coils

The leatheroid cells should be placed

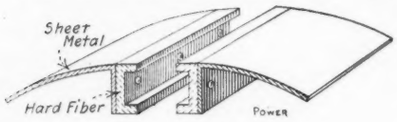


Fig. 22. Vise Attachments

in the slots before the insertion of the winding is started, but the cloth cells may be inserted one at a time, as the coils are put in. Both the cell and the coil should be dipped in powdered soapstone and the cell doubled around the part of the coil which is to go in the bottom of the slot. The upper halves of the first few coils,

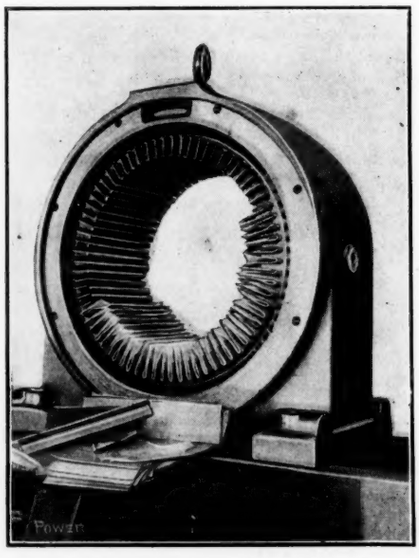


Fig. 23. Slot Troughs in Place

equalling the pitch or number, may be left out of the slots until the completion of the winding, as the lower halves of the last coils must lie beneath them. These coils are called the throw coils, and after they are in place all the following coil sides may be permanently inserted in the tops of the slots.

The lower half of each coil will force the treated cloth cell to the bottom of the slot, and will prevent the cell from doubling up under the coil as it would be apt to do if inserted before the coil. Before inserting the top halves of the coils, an insulating separating strip of heavy treated cloth or leatheroid must be placed on top of the coil in the bottom of the slot. The projecting ends of the cloth cells must be held taut while the upper half of the coils is being inserted, or the cells will be pulled down and doubled up under the coils. When using right and left coils, great care must be used that the proper number of right and left coils are used for alternate groups.

Testing the Winding

When the entire winding is in place, the coil terminals must all be cut off to a uniform length, and all the coils of each phase should be temporarily connected together with No. 22 bare annealed copper wire. The series of tests for grounds, crossed phases, etc., described in the article on location of trouble must then be made and any defective coils displaced before proceeding any further.

Securing the Coils in Place

After the tests are all made, the cloth cells should be cut off close enough to the core to allow the ends to be lapped over inside the slots and under the retaining wedges. If the coils do not fill the slots to a sufficient height to be firmly held in place by the wedges, a layer of leatheroid must be used to fill up the

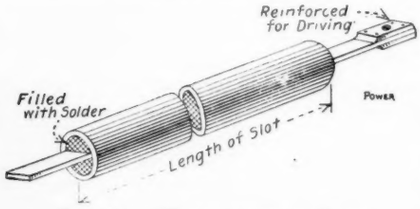


Fig. 24. Wedge-driving Tool

space. If new wedges are required, they must be made of the same dimensions and out of similar material to the original wedges. It is quite a difficult job to drive a long wedge without breaking it into pieces, and the tool shown in Fig. 24 will greatly facilitate this work. A piece of steel is cut slightly larger than one of the wedges and coated with a heavy oil. A piece of brass tubing a little longer than the wedge and large enough to admit the steel strip is procured, and the space between the strip and tube filled with solder. The solder will not adhere to the oiled strip, which may be withdrawn, leaving a slot large enough to admit the wedge. If the wedge is inserted in this tool and placed against one of the stator slots, it may be driven into place with the steel strip and a light hammer, without being bent or sprung.

If lacing rings are used, they must be of such diameter that the completed ring, with all the insulation in place, will be of an inside diameter about $\frac{1}{32}$ in. larger than the diameter of the circle made by the coils. If the ring is too large, it will double up when drawn up to the coils, and if too small, it will prevent the coils from resting on the bottoms of the slots.

If the ring is intended merely as an additional support for the end connections, its exact size is not so important, as the coils are held by the wedges, but if no wedges are used, the coils are liable to work outward and come in contact with the rotor unless properly secured.

Two men are required to lace a set of coils that are not held with wedges, one to pull the lacing taut and the other to drive the coil being laced to the bottom of the slot. The lacing should consist of three strands of ordinary wrapping twine in parallel, a needle made of soft copper wire being used to thread the lacing be-

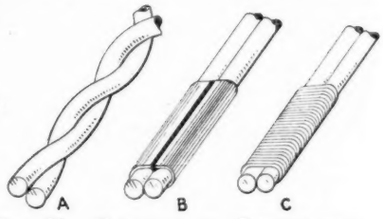


Fig. 25. Methods of Connection

tween the coils. The lacing rings should be given two wrappings of varnished cambric tape followed by a finishing layer of white linen tape and then well shellacked.

Connecting Up the Coils

The connections between coils must be made in the same manner as those of the original coils, a record of which should have been made before the old winding was disturbed. If for any reason this information is not available, the full-load current and speed of the motor given on the nameplate will aid in its determination. The number of poles per phase will be equal to 120 times the frequency in cycles per second, divided by the synchro-

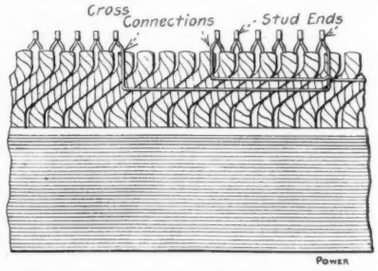


Fig. 26. Cross Connections

nous speed of the motor. If the synchronous speed is not given, adding about 6 per cent. to the full-load speed will give it. In order to determine whether series or parallel grouping of the poles is correct, find the number of circular mils in the wire, and divide this by the full-load current of the motor. If the figure obtained is below 400, the poles must be paralleled (see also table of winding data).

If the terminals of the coils have been properly brought out, the beginning and ending of adjacent coils will lie close together and may be neatly bent into pairs and soldered. Fig. 25 shows three

methods of making the connections between coils. The method shown at *A* should never be used, as the connections are sure to break off the first time it is necessary to untwist the joint for testing. Method *B* is the best and consists of applying tinned copper sleeves which may be readily removed and can be used several times. Method *C* is a good substitute for rush work and small coils, but the connectors can be used but once.

The cross-connections between groups are made of magnet wire with several layers of tape well shellacked in place. When two-element coils are parallel-connected, the cross-connections must be made of magnet wire three sizes larger than that used in winding the coils or else two parallel wires used, if only one size is available. The cross-connections must be cut to length and bent down parallel to the coil terminals so that the stub ends will all be uniform in appearance. In order to facilitate testing, enough slack should be left in the cross-connections to allow them to be raised clear of the winding. This slack may be bent back out of the way, as shown in Fig. 26, and the entire winding given a finishing coat of varnish, after which the motor will be ready for service.

The accompanying table gives rewinding data for several sizes of Westinghouse "Type C" motors, which will serve as a guide in recovering lost connection data.

REWINDING DATA FOR TYPE "C," TWO-PHASE, 60-CYCLE INDUCTION MOTORS

Horsepower	Full Load Speed	Voltage	No. Coils	Elements per Coil	Turns per Element	Elements Connected	Turns per Coil	Coils per Group	Size of Wire B. & S.	Full Load Current	Circular Mils per Ampere	Pole Groups Connected	Remarks
2	1700	110	72	2	8	Par	8	9	19	104	500	Par	Groups 2 in ser., 2 in par.
2	1700	220	72	2	8	Par	8	9	19	52	500	Ser	
2	1700	220	72	2	8	Ser	16	9	19	52	500	Par	Groups 2 in ser., 2 in par.
2	1700	440	72	2	8	Ser	16	9	19	26	500	Ser	
5	1120	110	72	2	7	Par	7	6	14	26	630	Par	Groups 3 in ser., 2 in par.
5	1120	220	72	2	7	Par	7	6	14	13	630	Ser	
5	1120	220	72	2	7	Ser	14	6	14	13	630	Par	Groups 3 in ser., 2 in par.
5	1120	440	72	2	7	Ser	14	6	14	6.5	630	Ser	
10	850	110	96	2	7	Par	7	6	14	52	630	Par	Groups 2 in ser., 4 in par.
10	850	220	96	2	7	Par	7	6	14	26	630	Par	Groups 4 in ser., 2 in par.
10	850	440	96	2	7	Par	7	6	14	13	630	Ser	
10	850	880	96	2	7	Ser	14	6	14	6.5	630	Ser	
10	1120	110	72	2	4	Par	4	6	12	52	500	Par	Groups 3 in ser., 2 in par.
10	1120	220	72	2	4	Par	4	6	12	26	500	Ser	
10	1120	220	72	2	4	Ser	8	6	12	26	500	Par	Groups 3 in ser., 2 in par.
10	1120	440	72	2	4	Ser	8	6	12	13	500	Ser	
20	1120	110	72	2	4	Par	4	6	9	96	540	Par	Groups 3 in ser., 2 in par.
20	1120	220	72	2	4	Par	4	6	9	48	540	Ser	
20	1120	220	72	2	4	Ser	8	6	9	48	540	Par	Groups 3 in ser., 2 in par.
20	1120	440	72	2	4	Ser.	8	6	9	24	540	Ser.	
50	850	110	96	2	3	Par.	3	6	9	220	475	Par.	Group 2 in ser., 4 in par.s
50	850	220	96	2	3	Par.	3	6	9	110	475	Par.	Groups 4 in ser., 2 in par.
50	850	440	96	2	3	Par.	3	6	9	55	475	Ser.	
50	850	880	96	2	3	Ser.	6	6	9	28	475	Ser.	

From a long series of experiments upon the transmission of heat through and from painted surfaces made by Prof. C. L. Norton some years ago, it was decided that the color of the pipe has little or no effect upon the radiation of heat. This view, so generally believed, has doubtless been confused with respect to the condition of the surface as regards glossiness or dullness. A dull surface has a radiation power of 120, while a glossy surface has about 101.

LETTERS

Perpetual Motion Again

A few days ago a perpetual-motion "crank" came into my engine room and began to talk perpetual motion to me. I told him that perpetual motion was against the laws of mechanics and he said he knew it but was going to try it any way. What he proposes to do is to set up a dynamo, a motor and a gasoline engine, each of the same horsepower, and connect the dynamo and motor shafts together, like a motor-generator set, with the addition of a clutch pulley for belt drive from the gasoline engine. He proposes to start the motor-generator set by means of the engine, to get the dynamo to generating; then turn the current from the dynamo into the motor, throw out the clutch that was used in getting the machine started, and let the thing run until it is worn entirely out! According to his idea, the dynamo will supply the current to drive the motor which will in turn drive the dynamo; simple, isn't it?

What is still worse, he thinks he will get excess current from the dynamo with which he can light up the town and drive all the machinery.

H. B. Adcock.

Newman, Ga.

[This fallacy has been explained away a good many times during the past thirty years. The arrangement would not continue running, after the clutch was pulled out, longer than the brief period necessary for the friction of the bearings and brushes to exhaust the momentum of the armatures. Because of the mechanical friction of bearings and brushes and the losses within the cores and windings of the two machines, the motor could not deliver to the dynamo as much power mechanically as it received from the dynamo electrically and the dynamo could not deliver to the motor as much electrical power as it received from the motor in mechanical power. This double shortage, of course, would prevent the machine from even driving its own shaft, to say nothing of delivering current for lights and motors.—Editor.]

Thawing Frozen Water Pipes

A couple of winters ago, I had about 150 ft. of ¾-in. pipe to thaw out and the only current available was that of a railway system supplied from rotary converters at 650 volts. The substation was 14 miles from the main power house, but by shutting down the converters and taking a time when everything was off the line we got about 500 volts. After rigging up a barrel as a water rheostat I attached one lead to a faucet at the extreme end of the ¾-in. pipe line and the other to a valve on the water main and lowered the upper terminal into the barrel until the ammeter showed 200 amperes; the voltage dropped to about 200. It took about 1½ hours to thaw out the pipe.

At another time the supply pipe to my house froze up; it was about 50 ft. long and ¾-in. pipe. I had a one-wire feed to the house from the trolley circuit and burned five lamps in series, grounding the return on the water pipe in the house.

I do not know how the current got back to the station; the water mains were all of wood. The trolley voltage was 650, but with the five lamps burning I got only 600 volts, showing a drop of 50 volts. On the night my pipe froze up, I connected the feed wire directly to the faucet of the water pipe and left it on all night, leaving the faucet partly open.

When I got up in the morning the water was running. I do not know how much current it took, but it could not have been very much because it was not enough to even warm up a No. 14 copper wire.

J. E. Bates.

Spokane, Wash.

Heating and Ventilation

Considered as power-plant problems. Layout and operation of systems and apparatus

The Single Pipe System of Heating

By William Kavanagh

With the single-pipe system of heating only one pipe to each radiator is necessary for the satisfactory circulation of steam. For buildings up to 12 stories in height it will be found that 1¼-in. radiator pipe will give good results, and the diameter of the risers varies as a rule from 2½ to 3 in. In high buildings the risers will range in diameter from 3 to 5 in., while the radiators are usually tapped for 1½- or 2-in. pipe.

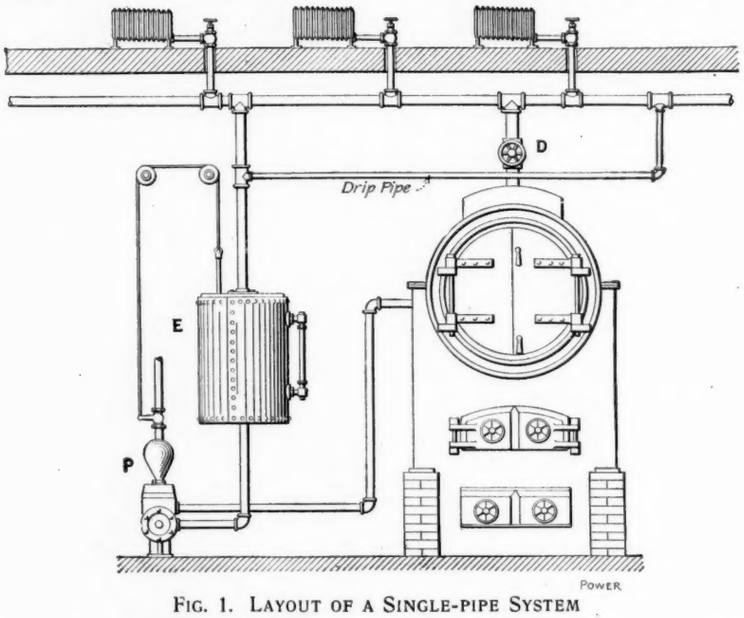


Fig. 1. Layout of a Single-pipe System

With the single-pipe system as now installed, the returned condensation is discharged into a tank that is usually situated at a height corresponding to the water level of the boilers so that the hot water will flow by gravity to the boiler-feed pump. Of course, this method is advantageous, but it will be shown that the use of the tank and pump is not at all necessary in returning the water of condensation to the boilers.

At first sight it would appear that circulation of steam cannot be attained with the single-pipe system, but on further consideration it will be found that the circulation is almost perfect. This is especially true when the radiators are properly erected and fitted with automatic air valves. The circulation of steam through the entire system is facilitated when the termination of each riser is extended and fitted with an air valve. The radiators are so constructed as to have the end at which the steam enters ¾ in. lower than the other. The incline given to each radiator makes it possible for the water of condensation to flow back by gravity toward the boiler.

If a receiving tank is used, it must be fitted with a gage-glass to show the water level, and a float is placed in the tank to control the steam or electric pump which discharges the water of condensation into the boilers. Such a system is shown in Fig. 1. The steam varying in pressure from that of the atmosphere upward passes out to the different risers through the main *D*, the condensation being returned to the tank *E*, equipped with float control. The tank *E* and pump *P* can be dispensed with if the drips are all connected to a common return which may be connected to the blowoff or the lowest part of the boiler.

In raising steam for this system, all valves should first be opened so as to avoid snapping and cracking in the pipes and radiators. The entire heating system will then become a part of the boiler and a noiseless circulation will result. If, however, steam is first raised and then allowed to flow through the piping, there will be plenty of noise.

One method of running the risers and attaching the radiators is shown in Fig. 2, and Fig. 3 shows another method which is excellent, as it allows each riser to be independently dripped and piped back to the tank or return pipe, thus insuring complete drainage of the system.

Fig. 4 shows how radiators may be connected to the riser when it is located in a corner, and Fig. 5 illustrates a method of connection when more than one radiator is required on the same pipe. The riser is shown at *R*. A Y-fitting is connected in the "run," as shown at *P*, to admit steam to the second radiator, which should be slightly elevated and pitched toward the riser. Fig. 6 shows another method of connection, and Fig. 7 shows a radiator attached to a riser terminating on the highest floor. The riser extends above the radiator and has a valve at *A*

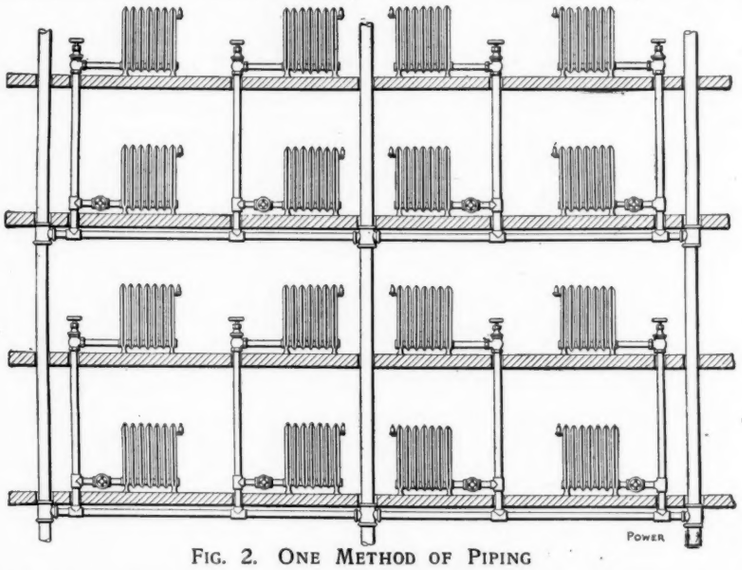


Fig. 2. One Method of Piping

to relieve the system of air and improve the circulation. In some buildings, the extended leg of the riser reaches almost to the ceiling.

An important addition to the single-pipe system of heating is to have the

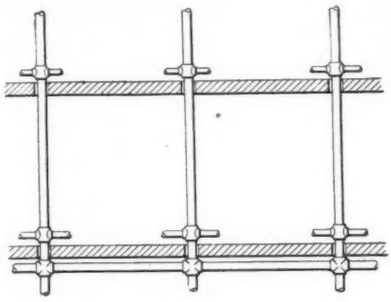


Fig. 3

radiators connected to an air line leading to a vacuum pump. This facilitates the removal of the entrapped air, improves the circulation and permits a lower steam pressure on the boilers. With the air line installed, a steam pressure varying from 1 to 3 lb. will produce an excellent circulation throughout the entire system. In a certain 14-story building, good circulation is obtained in the radiators on the highest floor when the gage registers ½ lb. pressure, and during the coldest weather the pressure does not exceed 3 lb.

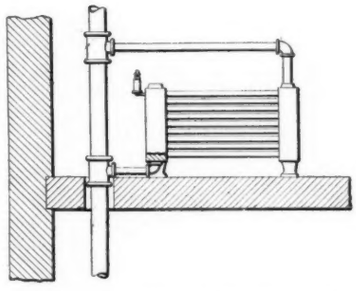


Fig. 6. Connection of Radiator to Riser

LETTERS

Piping a Water Heater

The illustration of "Proper Connections for Good Circulation" accompanying Mr. Jones' letter in the Jan. 2 issue does not agree with my idea of proper connections, even though it does represent a common practice. I object to the location of both the hot- and cold-water inlets as shown, and think I can point out a more logical arrangement.

In Mr. Jones' sketch, the cold-water connection is at the top, but the pipe is continued down the inside of the tank for about three-fourths of the depth. If it is good practice to have the cold water discharged into the lower part of the tank, why not do it in the best and easiest way by making the connection at the lowest possible point; that is, directly into the bottom head, or through a cross one branch of which leads to the heater and the other to the draw-off valve?

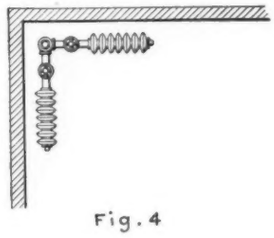


Fig. 4

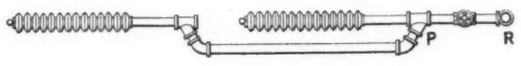


Fig. 5

Surely no one will claim any advantage for the present method of jacketing the cold-water inlet pipe, and it has the disadvantages of taking heat from the surrounding hot water, so that the water drawn is continuously reduced in temperature.

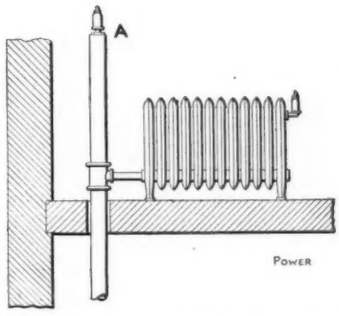


Fig. 7. Connection of Radiator on Top Floor

Where the cold-water inlet connection is made at the top of the tank, a continuation of the pipe down the inside of the tank is a necessity, as otherwise the cold water would shunt across to the hot-water outlet whenever water is drawn, but the amount of hot water which may be drawn is limited to the depth that the cold-water inlet pipe is submerged. If the cold-water connection is in the bottom head, the entire tank may be filled with hot water, instead of perhaps three-fourths of it, and all of this supply may be drawn off at practically constant temperature.

In regard to the hot-water return from the heater, it is certainly logical to say that if circulation is promoted by having this connection on the tank higher than the cold-water outlet from the tank to the heater, then instead of making this connection on the side of the tank at about half the depth, the best arrangement is to make it at the top; in fact, at the point now used for the cold-water inlet. Some may object to this arrangement on the ground that when hot water was drawn off the cold-water supply would not only enter the bottom of the tank but would force itself through the

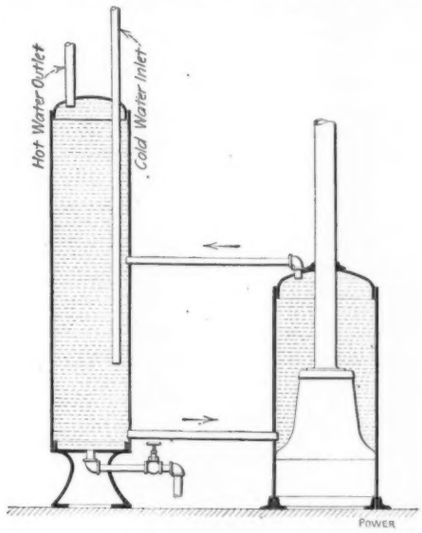


Fig. 1. Mr. Jones' Connections for Good Circulation

heater coil and discharge into the top of the tank on top of whatever hot water was still there. The fallacy in such an objection is that the cold water cannot rise any faster in the pipe leading out of the heater than it rises in the tank, while on account of the extra pipe friction, it will not actually rise quite as fast. This action will be readily apparent to everyone if it be imagined that as the hot water is drawn, some much heavier liquid, such as mercury, comes in through the cold-water connection.

Circulation is entirely a matter of difference in weight between equal volumes

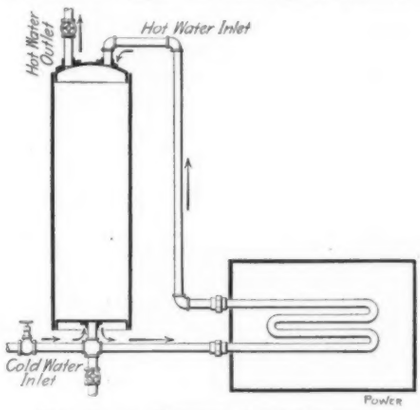


Fig. 2. A Better Arrangement

of hot and cold water. Starting with the system filled with cold water, if the hot-water return is on the side of the tank and only a single horizontal coil passes through the heater, there is for some time an uncertainty as to the water in direction of motion. Consequently, both hot and cold water are passing each other

in both connections between the tank and the heater. This results in overheating the coil in the heater, if it is in the firebox, and retards the circulation until there is an appreciable temperature difference in the water above and below the side opening. This defect is remedied by connecting the hot-water inlet to the top of the tank.

I do not object to Mr. Jones' sketch on the ground that such an arrangement will not furnish hot water, but I do maintain that the suggested arrangement will provide better circulation, a greater supply of hot water, a more uniform temperature and will be less expensive to install.

A. S. MERRILL.

Easton, Penn.

In the Jan. 2 issue, Mr. Jones shows his lack of practical experience with hot-water heating. I expect that the water can be used as heated if desired, as this is one reason why so many range boilers are being thus connected; there is hot water as soon as the heat strikes the circulating pipe and it is not necessary to wait until part of the reservoir is hot.

The manufacturers may put the cold-water inlet on top of the range boilers, but mainly because they have always done so, and it is easier for the plumber to make the connection. Of course, there are exceptions.

I can assure Mr. Jones that the saving effected was "not on paper" but in good paper money. Although the exhaust-pipe area was reduced, the heating coil acted as a condenser, and instead of causing a back pressure on the engine it would have a tendency to reduce the back pressure. The elbows and tees on the exhaust are outside of the question as they were in place at the beginning.

The vibration from the exhaust is taken up by the long upright pipes and affects the tank but little. There has been absolutely no water-hammer.

There is a gage on the exhaust pipe and it has never shown a back pressure greater since the coil was installed than it did before.

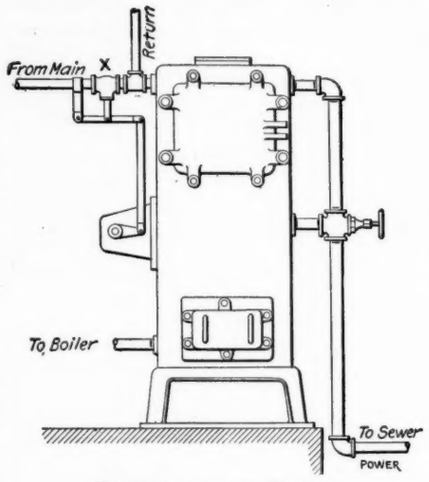
JAMES E. NOBLE.

Toronto, Can.

Leaky Valve Wastes Heat

The illustration shows one of the open types of exhaust heater used in connection with a vacuum system. The water bill was found to be high, and upon investigation the valve *X*, which is operated by a float on the interior of the heater, was found badly cut, and consequently it leaked considerably. The cold water from the city main was flowing into the heater and condensing the steam which should have been used to heat the building. The return water from the radiators was also wasted to the sewer.

The valve was repaired so that it would shut tight when the float was raised and the supply of exhaust steam was found to be sufficient to heat the building. The live-steam pipe to the radiator system was closed and less coal was burned as



CONNECTIONS TO HEATER

the feed water was going to the boiler at 160 deg. There are, no doubt, other cases of this kind.

C. R. MCGAHEY.

Baltimore, Md.

Radiator Troubles

How the steam connections were made to two radiators situated in a lobby outside of a dining room is shown in Fig. 1.

The steam piping ran underneath the lobby and was connected vertically to the radiator by two 1-in. pipes 4 ft. 6 in. long. It was about 15 ft. from the steam main to the first radiator and about 35 ft. to the second. The pipes were well lagged and on the return side of each

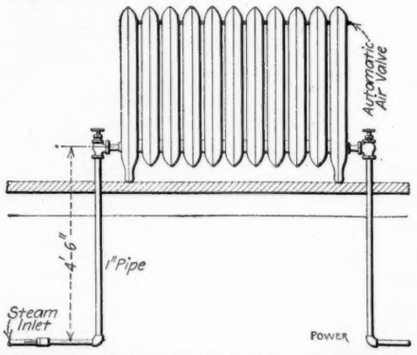


FIG. 1. ORIGINAL METHOD OF PIPING RADIATOR

radiator was a steam trap discharging to a drain.

The radiators were first coupled up as in Fig. 1, but they did not give satisfaction. Unless the valves were opened fully, the radiators would not get hot and when they were opened wide there was a good deal of water-hammer, which eventually split several segments. To remedy the trouble several experts were called, and the first expert put a check in the running thread, Fig. 1, in the steam-inlet pipe. This consisted of a lead disk with a small hole about $\frac{3}{16}$ in. in diameter, the idea being to prevent a

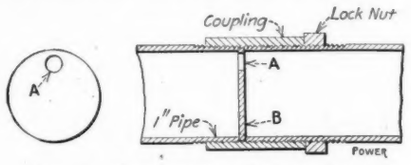


FIG. 2. THROTTLING STEAM SUPPLY

sudden rush of steam and water from getting into the radiator when the valve was opened fully. This plan did not answer very well.

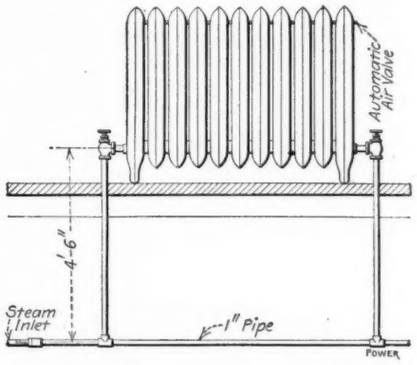


FIG. 3. SHUNT CONNECTION ADOPTED

Another firm was called in and on taking the check out of the steam pipe the $\frac{3}{16}$-in. hole was found to be at the top of the disk, shown at *A* in Fig. 2. This allowed the condensation to fill the pipe to the level of the hole *A*. It was intended, of course, to have the hole at the bottom of the pipe, as at *B*, so as to

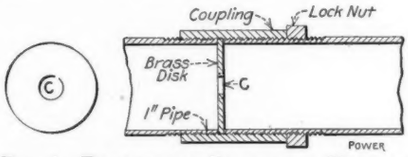


FIG. 4. THROTTLING DISK WITH HOLE IN CENTER

allow the condensation to run through as fast as formed.

The connections to the radiators were now altered and connected up as in Fig. 3. With the shunt connection shown, the condensation had a straight run to the trap and it was not necessary to pass it through the radiator as in Fig. 1.

A brass check was substituted for the lead one and a $\frac{1}{16}$-in. hole was made in the middle of the disk, so that at the worst the pipe could only fill up to about one-third its diameter before the water would flow through the hole in the check.

On opening the valves the radiator was found to warm up equally from both ends and got thoroughly hot. No more trouble was experienced from water-hammer.

O. G. A. PETTERSSON.

St. James, Manitoba, Can.

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Contents

	Page
British Practice in Superheating	138
Saving Fuel with Low Pressure Turbines	142
Wire Rope Splicing	143
Connecting Rod Ends	144
Initial Cylinder Condensation	145
Light Engine Frame Fractured	146
Heat Transmission	147
Boiler Explosions in England	148
Rewinding an Induction Motor Stator	149
Perpetual Motion Again	153
Thawing Frozen Water Pipes	153
The Single Pipe System of Heating	154
Piping a Water Heater	155
Leaky Valve Wastes Heat	156
Radiator Troubles	156
Editorials	157-158
Readers with Something to Say: Vertical Check Valve Did Not Work....Blow Hole Caused Crack in Shaft....Oil Tray Stand....Dynamite for Removing Pinion from Shaft....Homemade Ejector....Flywheel Repair....How to Test and Treat Feed Water....Isolated Plant Engineers' Opportunities	159-161
Questions Before the House: Inertia of Air Compressor Intake....Coal and Clinkers....Broken Valve Crosshead....Cause of Boiler Explosions....Isolated Plant Owners Responsible....Cost of Power in New England Mills....What Means the Dome?....The Delray Boiler Tests....Knocking in Air Compressors....Feed Water Regulators....Engineers' Wages....Figures for Mr. Fitzgerrell....Christie Air Steam Engine	162-166
Inquiries of General Interest	167

POWER

A Few Factors in Economical Operation

No fixed rule can be given and no particular type of equipment recommended which will always insure maximum efficiency of operation in any and all power plants, but some of the factors in economical service which are working out well in a few stations recently visited may profitably be mentioned. Leading engineers are attacking the cost question from more than one angle, in the first place; that means a good deal in itself, for one gets more side lights on the behavior and possibilities of his equipment if he investigates its service along several different lines. For example, the problem of cutting down the losses occurring in stand-by periods requires one point of view, the more complete measurement of the raw material of power, so to speak, on the steam side of the house is another matter bearing upon costs in a different way; thirdly, as the old-fashioned country minister used to say when he had just got warmed up in his sermon, there is a great deal to be done along the line of carrying the load to advantage when several different sizes and types of prime movers are concerned.

One plant is getting some results from the use of supplementary dampers on individual boilers, so that the draft on every banked fire goes away down to the bottom of the gage when the service of the unit is not required. In this case each stand-by damper is set in the boiler uptake and the dampers of every battery are controlled by chains leading to adjusting hooks on a draft-control board at the side of the setting near the floor level. As this is a Western station located in a field where the cost of coal is prohibitive, it burns fuel oil, which means additional control of the heat units blown into the furnace through appropriate valves and bypass piping.

The owners of this station thought it a good investment to spend a few hundred dollars in steam and water meters, recording thermometers and curve-drawing instruments, which will show the chief engineer and his superiors, the assistant operators in the turbine room and the firemen as well, the conditions which existed at any hour of the twenty-four in the steam end of the plant, as regards all the important heat-carrying fluids and gases. It is not going to take two or three college professors and a score of willing but perhaps somewhat inexperienced student assistants to find out when this station departs from its normal economy by a percentage which calls for prompt action.

In another case the plant owner has put individual motor-driven fans in the boiler uptakes, each boiler having its own short stack. The motors are equipped with variable-field speed control, which is the real point of the situation, and they are designed to operate at diverse speeds within a range of three to one without falling off very far in efficiency. It is a different story here from that in the plant where fan speeds are regulated by varying dead resistance in series with an old railway motor. Again, improved conditions of operation have resulted from the concentration of all auxiliary electrical control equipment at a single section of the switchboard, including the relocation of the exciters at a point within a few feet of the switchboard operator. Space has been saved by the installation of compressed air piping in place of dead pipe railings in the gallery sections of the boiler room, and a recent extension of the latter has been greatly improved from the standpoint of supervision and replacement of stoker and furnace parts by a twenty-five per cent. increase in the width of the firing aisle.

The adoption of the now well known plan of passing the condensate from the lower tubes of the surface condenser through a heating section in close contact with the heat of the exhaust steam is a point which is receiving a good deal of favorable consideration in another locality, and in still another place the

cost of excavation to allow the condensing apparatus to be located far enough below a small canal to obtain circulating water by gravity was found well warranted.

The cost of power was cut twenty per cent. in six months in another station by simply taking greater care to handle the load on individual prime movers in such a way that no unit would for any length of time be run at much less than half load, three-quarter load being the more common rate. In this case the problem was complicated by the fact that alternating- and direct-current generating units were run side by side in the same building, the former feeding the same network as the latter, through rotary-converter substations in the suburbs. By watching the location of the load carefully it was possible to reduce the amount of idle running in the plant to a surprising extent.

A close supervision of the use of supplies and the strict limitation of working boiler pressures to values below the safety-valve settings produced notable gains in efficiency in several stations.

Six Year Engineering Course at Columbia

At the annual meeting of the trustees of Columbia University on Jan. 8, it was decided to extend the engineering courses to six years so as to include two years of regular academic work. Under this arrangement, after September, 1914, the engineering courses will be open only to those who have completed two years in the arts course in Columbia or some other college of recognized standing.

In view of the important standing now accorded engineers and the ever increasing scope of their activities, it is essential that their training include something more than merely technical knowledge; in other words, their education must be broad. As a means toward this end, the recent action of the Columbia trustees is commendable. However, we question whether a compulsory six-year course will not deter many (for financial or other equally strong reasons) from entering upon an engineering career. Might it not have been better to have left the four-year course as optional, at the same time recommending the six-year course to all those who are in a position to take it? This practice has already been followed by several other universities.

Steam Pipe Supports

The constant movement of a steam line due to expansion and contraction necessitates the use of supports that will offer the least resistance to this movement so that no undue stress will be transmitted to the various connections.

The variations in the length of a steam line depend upon the initial length of the line and the difference in temperatures between that at which the line was put up and that of the steam passing through. In a very long line, or where superheated steam is used, these variations are considerable and must be provided for by designing and arranging the supports so as not to prevent the free movement necessary to relieve the expansion stresses, except, of course, at such points as are intentionally selected as an anchorage. There is also a lateral movement of the line due to the push of the branch pipes for which care must be taken.

There are a number of different kinds of pipe supports in use that meet all the requirements and a proper selection can only be governed by local conditions. For example, there are hangers from above supported from the bottom cords of the roof trusses; brackets on which the pipe directly rests; steel pillars or posts of sufficient slenderness to allow free movement, which are sometimes convenient for carrying the pipes from the crown of the boilers or from the brick settings; rollers carried by brackets and other devices.

The most common form of support is, perhaps, the hanger in which the pipe is suspended. This type gives free movement to the pipe but lacks a sufficient stability; consequently, the line will often be set to swinging or vibrating by the pulsations due to the draft of steam from the engines. This may usually be checked by lightly wedging the pipe at some point where the branch passes through a wall or near a column or other fixed object. When the pipe is simply supported on brackets it will not vibrate so readily.

Brackets are often hollowed out to suit the contour of the pipe, but this is a rather doubtful advantage as they tend to prevent all lateral movement and thus cause a strain on the branches as well as on the bracket supports and fastenings. It is better to have the top or table of the bracket flat so that the pipe will be free to move both ways. To prevent undue wear on the outside of the pipe, small wearing strips are often inserted between the surfaces of the pipe and the bracket with excellent results. These strips should be from about $\frac{3}{8}$ to $\frac{5}{8}$ in. thick and can easily be held in place by means of light rings encircling the pipe. They should, of course, move with the pipe and not be fastened to the bracket; otherwise they would lose entirely the purpose for which they are intended.

The use of rollers for carrying pipes is usually not so good an arrangement as the plain bracket where a rubbing contact is introduced because of the latter's greater tendency toward stability. A pipe line resting on rollers is, however, less liable to vibrate than one suspended in hangers. Perhaps the greatest objection to the roller is that it is liable to become fast and consequently wear the pipe, a condition which naturally would not be looked for with this type of support and, therefore, might not be noticed until some damage had resulted.

One good operating kink is many times invaluable to a hundred engineers, but occasionally a contributor, for fear of aiming too wide of the mark, will spend hours of his time for relaxation in dilating upon his subject when a few simple words to the point will tell the story. Brevity is as much the soul of writing for your paper as it is of wit.

Of the thousands of steam boilers installed in the basements of buildings and under sidewalks, few are removed. Many of them are old but are allowed to carry pressures ranging between 80 and 90 lb. per square inch. Something serious will happen one of these days.

Every operating engineer who is interested in the work being done throughout the United States in vocational training should read of it in the twenty-fifth annual report of the commissioner of labor at Washington. It may be had on application.

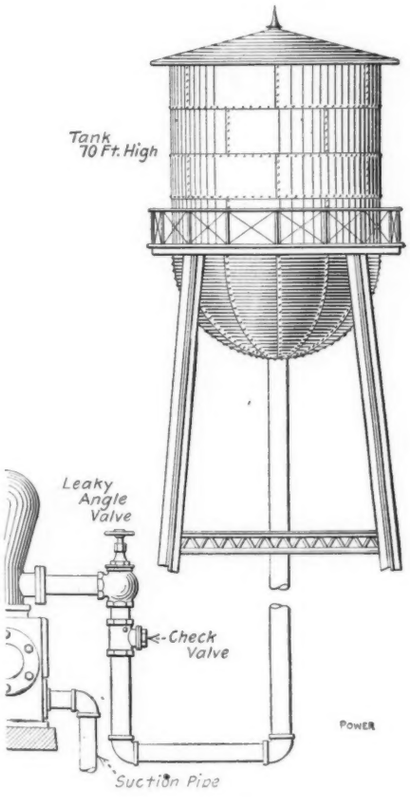
No trouble at all in getting data regarding boiler accidents from the new board of boiler inspectors of New York City. It is a good beginning and most gratifying.

Readers with Something to Say

A letter good enough to print will be paid for. Ideas, not mere words, wanted

Vertical Check Valve Did Not Work

Some few days ago the writer was called out on a trouble job in a small light and water plant the engineer of which said that something was the matter with the check valve in the sprinkler-tank line and that it had never worked at all. He had taken the cap off several times, but he could not locate the trouble. The tank on the tower was kept full of water all the time on account of fire insurance. The tank was filled every night, but in the morning all the water was back in the reservoir again because the angle valve and check valve shown in the accompanying figure leaked, the water going back through the pump valves.



SHOWING LOCATION OF THE CHECK VALVE

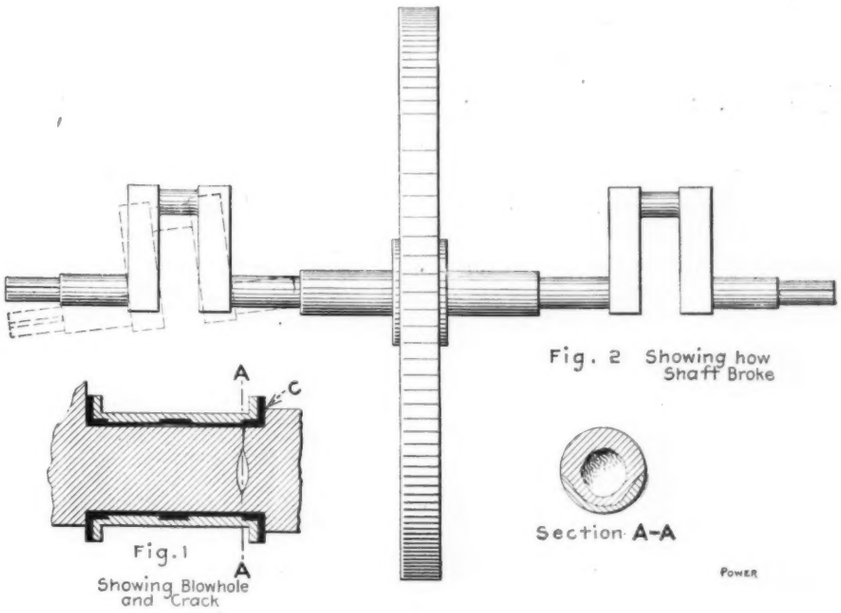
The trouble was that the check would stay open all of the time because the pressure was balanced between the pump and the tank, and the check sank to the bottom. If there had been a strong back flow the check might have worked. I fixed it by placing a spring under it to make it stay up to its seat. It is easy to see that the check ought to have been placed in the horizontal line.

H. T. FRYANT.

Columbus, Miss.

Blow Hole Caused Crack in Shaft

While employed as master mechanic in one of the steel mills in Austria I had a most interesting experience. On a certain morning one of the engineers came to my office and asked me to go with him to the bessemer plant and examine the 1200-hp. blowing engine. As something seemed to be wrong with one of the main bearings, I put my hand on the shaft close to the bearing face, as at *C*, Fig. 1, and found that apparently minute babbitt filings were running out with the oil. It is putting it mildly to say that my curiosity was aroused, and I decided to wait until after the heat was finished so that the engine could be stopped and the shaft examined.



Stopping the engine meant shutting down the converter plant as we had no spare unit. We were lucky that we did not let any objections on the part of the foreman prevent us from shutting down, as later events proved.

When the engine was stopped the cap of the bearing was taken off and the shaft examined. About 5/8 in. from the face of the bearing we discovered a very fine zigzag crack which extended over about half of the circumference of the shaft, which was 14 in. in diameter. The circumstance seemed serious enough to warrant a more thorough investigation before the engine was again put into service, and we decided to lift the shaft out of the bearings for the purpose of a more complete inspection.

The shaft had been raised about 8 in. clear of the bearings when it broke with a loud crash, falling into the bearings and breaking them. Of course, the break in the shaft had occurred where the crack had been. We examined the faces of the break and found that the shaft contained a blow-hole at that point, about 8 in. in diameter and 3 in. thick, which had not come out even when the shaft had been forged—a most remarkable fact. When the break occurred about one-tenth of the full area of the shaft still remained intact; the rest of the fracture showed a rather smooth surface and no doubt it had been developing for the past six years, during which time the engine had been in constant use.

In view of the comparatively slight damage that was done we felt that we had escaped very luckily; had the shaft broken while the engine was in full operation the results would have been disastrous indeed.

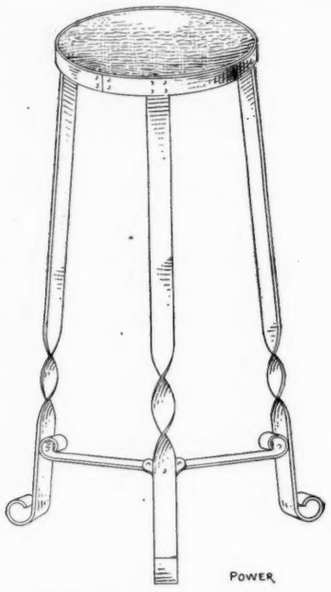
ALOIS HAUSER.

South Chicago, Ill.

Oil Tray Stand

Having seen in POWER an illustration of a stand for oil cans, I am lead to describe the one I made and am using.

It is made principally of 1x⅛-in. galvanized strips. The top of the table, 13



HOME-MADE OIL-TRAY STAND

in. in diameter, is made of wood held inside the band.

I have a nickel-plated tray on which to set my cans. The whole presents a good appearance and cost for material, aside from the tray, just 20 cents.

F. W. BAIR.

Hancock, Mich.

Dynamite for Removing Pinion from Shaft

The machinists in the plant where I am employed pulled off a stunt recently, a description of which may help someone out of a tight place some time.

We were all to have a half holiday to attend the county fair and on this particular day at about 10:30 a.m., the 3-inch drive shaft on a mill broke off close in the end of the driving pinion. The pinion was about 10 inches in diameter by 14 inches long and had 15 teeth. The mill was needed badly the next morning.

The first step was to get a new shaft, which was an easy one, as the manufacturers of the mill have a local storehouse for repairs and we had only to send the teamster a few blocks to get it.

The second problem was to get the pinion off of the old shaft and onto the new one, and as it had taken about six hours of hard sledging and drilling, to get this same pinion off once before when the shaft broke, it looked as if someone was doomed to miss the fair.

All efforts to drive out the old shaft did not seem to have any appreciable effect. Someone suggested dynamite, and they grabbed at the suggestion like a drowning man grabs at a straw.

The pinion was laid on its side at a safe distance from all buildings, one stick of dynamite was set against the end of the shaft where it was broken off and then mudded in with stiff clay. When everyone got under cover the dynamite was exploded. The concussion loosened things up so that five minutes' work removed the shaft, and everyone went to the fair.

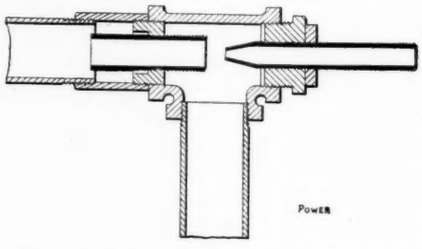
EARL PAGETT.

Coffeyville, Kan.

Home Made Ejector

The figure shown herewith illustrates the construction of a steam siphon or ejector that can be easily and cheaply made with a few common pipe fittings.

I have made five of these lately, and two of them have been in service 24 hours per day for the past few months. All are of the 3-in. size, the suction pipe is 3 in. while the outlet or discharge is sometimes reduced to 2½ in. The list of fittings needed is as follows: One 3-in. tee, one 3x1½-in. face bushing, one 3x1-in. bushing, one 3-in. pipe coupling, one 1-in. locknut (when the locknut was not at hand I sawed a piece off a 1-in. coupling and used it as a locknut.), one 1½-in. nipple 6 in. long with a thread on one end long enough to permit it to be screwed through the face bushing to the center of the tee; omitting the thread on other end; one 1-in. nip-



SECTION SHOWING DESIGN OF EJECTOR

ple drawn to a point and a ⅜-in. hole drilled into the small end.

This forms the steam nozzle and is screwed into the tee through the 3x1-in. bushing to within 1¾ in. from the 1½-in. nipple which forms the delivery nozzle. The 1-in. nipple has a long thread cut on the nozzle end to permit the adjustment of the nozzle as the siphon will not work unless it is properly adjusted. This can be done only by trying it, and when the nozzle is in the right place, the locknut is run up tight against the 3x1-in. bushing.

The place where the nozzle works best is generally about 1¾ in. from the 1½-in. nipple, which forms the delivery nozzle. The 1½-in. nipple is screwed through the face bushing to the center of the tee.

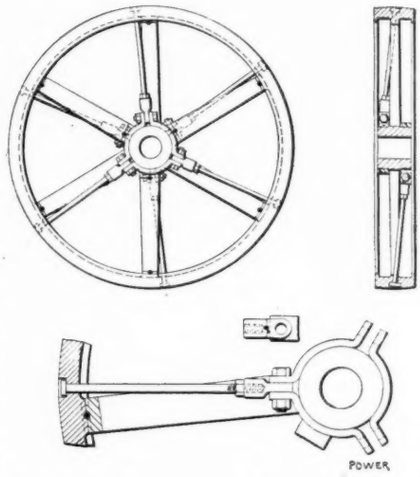
The face bushing is screwed about half of its threads into the tee and the 3-in. pipe coupling is screwed on the other half of the threads. All similar siphons I have made work on 12- and 15-ft. lifts throwing 2½-in. streams of water.

ROMAN S. WILHELM.

Indianapolis, Ind.

Flywheel Repair

The engine carrying this wheel was equipped with a ball governor having no automatic stop. The governor belt broke and permitted the engine to run away and break the wheel.



SHOWING MANNER OF REPAIRING FLYWHEEL

Five of the six spokes broke at the rim and at the hub, but the remaining spoke broke at the rim only.

The accompanying figure illustrates the manner in which the wheel was repaired.

This wheel was repaired six months ago and has been giving satisfaction ever since. When it is taken into consideration that this engine runs almost 24 hours a day, it is reasonable to assume that the repair will last as long as the engine.

The ⅞-in. studs shown in the cracks were put in and riveted to prevent the arms from "walking" out of position.

JOSEPH F. PFLUM.

Canton, Ill.

How to Test and Treat Feed Water

I think it is generally conceded by engineers that the weak place in a modern steam plant is the boiler equipment. There have been wonderful improvements in engines and electrical machinery in the last few years, but little has been done to make life easier for the boiler-room force.

In my own experience, the principal trouble is with scale and corrosion. I have tried numberless kinds of boiler

compounds, and at first got excellent results from all of them. But invariably disappointment came, due, I suppose, to the continual changing of the composition of the water at different seasons of the year.

We have water here containing at different seasons from 30 to 50 grains of solids to the gallon; these are of such a nature that I have screwed on a 2-in. pipe fitting by hand, and in two months I have been unable to take the fitting off without splitting it.

Some years ago I started to study up on water softeners, believing that my best course lay in softening the water before it went to the boiler. I wrote to an engineering magazine for advice, and in reply received a letter advising me by no means to undertake anything of the sort, as I would get into all kinds of trouble. It ended by giving me the name of a firm making water-softening apparatus. I wrote to this firm, and in reply got a proposition that would have meant an expense of over $2000 if I had taken it up. As the entire boiler plant to be protected by this apparatus cost less than this amount, it can easily be guessed that I did not pursue the matter much further.

I have kept a close watch on the trade papers, and have seen a good many articles by college professors, etc., on the subject, but invariably they have been too heavy for engineers who, like me, are shy on technical education, or who have no time to wade through it all to get the application for their own needs.

I have studied and experimented and talked to everybody I met who knew anything about the subject, until I can now keep my boilers absolutely clean with about two hours' work per month.

I use lime and soda only, but it is important to get the right proportions of each, and this is easily done.

The apparatus and chemicals needed are, one burette graduated in $\frac{1}{10}$ c.c., one 50-c.c. graduate cylinder, 2 oz. of phenolphthalein in solution, 2 oz. of methyl orange, and 4 oz. of $\frac{1}{10}$ normal sulphuric acid. These chemicals can be obtained of any chemist, and they will be sufficient for a year or more.

In testing the treated water, it is necessary to find the degree of alkalinity and of causticity. First secure an analysis of the raw water, and for each grain per gallon of carbonate of lime, as shown by such analysis, put into each 1000 gal. of water to be treated 0.098 lb. of common unslacked lime. To each grain per gallon of carbonate of magnesia add 0.234 lb. of lime; for each grain per gallon of sulphate of lime add 0.125 lb. soda ash; for each grain per gallon of sulphate of magnesia add 0.08 lb. of lime and 0.14 lb. of soda; for each grain per gallon of chloride of magnesia add 0.1 lb. of lime and 0.17 lb. of soda.

To provide for the constant changes in the water, it will be necessary to test the treated water occasionally, which is done as follows: Measure accurately 50 c.c. of the treated water and pour it into a clear-glass tumbler. Add with a medicine dropper 2 drops of the methyl orange and a few drops of the phenol. Shake until thoroughly mixed. Then fill the burette with the sulphuric acid and run it into the tumbler, drop by drop, until the red color in the water just changes to yellow. Take the reading of the burette before and after, the difference between the two readings being the amount of acid necessary to make this change. Each $\frac{1}{10}$ c.c. indicates 1 part per 100,000 of causticity.

Now run in more of the sulphuric acid until the yellow color just changes to pink; each $\frac{1}{10}$ c.c. of acid used indicates 1 part per 100,000 of alkalinity. The alkalinity includes the causticity, and is therefore always the greater. In practice, the causticity should be about half the alkalinity.

If the test shows less than half, more lime should be added; that is, there should be more in proportion to the soda used. I slake up at one time enough lime and soda to last several days, and put enough of the mixture into my settling tanks so that the water in the boiler begins to show just a little discoloration in the gage-glass. If too much is used it might cause priming, but a little care at first will soon show the proper amount to use. The really important thing is to change the proportions of lime and soda to suit the changes in the raw water. I use two wooden tanks for settling the water, each large enough to hold water for six or eight hours' run, using them alternately.

I believe that any engineer can rig up such an outfit at small expense, and that by using a little judgment in following out these directions he can, in the main, get results that will surprise him. I will be glad to hear from anyone trying the plan, and will answer any questions put to me by anyone wanting further information.

ALBERT J. WICKES.

San Luis Obispo, Calif.

Isolated Plant Engineers' Opportunities

In view of the continuous encroachment of the central station, it is up to the isolated-plant engineer to put on his thinking cap, and find out for himself in what way he can increase the efficiency and the economy of the machinery in his care.

It is safe to say that not a single plant is running where some economy could not be effected, some improvement made involving greater efficiency, if the engineer would but take the time and trouble, apart from his ordinary duties, to look closely into all the details of his plant.

How often one sees large quantities of wasted coal and gases pouring out of the stack in the form of smoke. The only effective "smoke preventer" is a good fireman.

In very many small plants, exhaust steam goes direct into the atmosphere and is lost, when useful work might easily be obtained from it for heating the boiler-feed water, etc. The advantages of heating the feed consist not only in a direct saving of fuel but also in a reduction in the strains in the boiler, tending to prolong its life, and minimizing the danger of leakage and consequent deterioration, which is often very rapid. A little ingenuity on the part of the engineer, and the exhaust steam from noncondensing engines could be made to effect a considerable saving in the coal account.

Another way in which to effect a saving is to place a series of pipes in the flue between the boiler and the stack and pass the feed water through these pipes. The percentage of saving effected in heating the feed water by such an economizer, or by an exhaust-steam feed-water heater, is found as follows:

$$100 \times \left(\frac{T - t}{H - t}\right) = \textit{percentage of saving}$$

where

T = Final temperature of the feed water;

t = Temperature of feed water before heating;

H = Total heat of the steam in the boiler at any pressure above the atmosphere.

With gases leaving the boiler at a temperature of 650 to 700 degrees Fahrenheit the temperature of the feed water from the hotwell may be raised in such an economizer as high as 300 degrees Fahrenheit and even higher, resulting in a very decided economy. It is not desirable to put in an economizer when the temperature of the gases on leaving the boiler is below 400 degrees Fahrenheit.

To further insure economy in the use of the steam and the efficient operation of the engine generally, the intelligent application of the steam-engine indicator is not only necessary but imperative. The indicator diagram affords an excellent guide in setting the valves of the engine; it enables the horsepower developed to be readily calculated, and it generally reveals the whole behavior of the steam during the performance of its work in the steam-engine cylinder.

If the operating engineer would in every case rise to his opportunities, there would be little danger (except in some extreme cases) of his being supplanted by the use of power from the central station.

JOHN CREEN.

Seattle, Wash.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Inertia of Air Compressor Intake

Some time ago, Snowden B. Redfield wrote an interesting article in POWER concerning the gain in the volumetric efficiency of an air compressor, made possible by utilizing the inertia of the moving column of air in a long intake to partially compress the air in the cylinder at the end of the suction stroke. In a more recent issue, John S. Leese has added a few words on the same subject. That there is such an inertia effect and that under some conditions it has a tendency to increase the volumetric efficiency of the compressor I think no one will deny, but the gain is not so great as Mr. Redfield would lead one to believe.

To illustrate his views he calculates a specific example. His method is interesting and probably gives a fair approximation of what might be expected, but when he states that the results represent an increase in volumetric efficiency of 5 per cent., he takes into account only the pressure and the volume and overlooks the third important factor, temperature.

In the case under discussion, since no effort is made to cool the intake and since the number of compressions is so great, the compression will be very nearly adiabatic. If it is assumed that this is the case, then the rise in temperature can be calculated by the formula

$$T_2 = T_1 \left(\frac{p_2}{p_1}\right)^{0.29}$$

where T_1 and T_2 equal the absolute temperatures before and after compression and p_1 and p_2 the respective absolute pressures. Since an inlet temperature of 60 deg. F. was assumed the temperature of the air in the cylinder after it has been compressed to a gage pressure of 0.726 lb. per square inch by the inertia effect will be

$$T_2 = (460 + 60)\left(\frac{14.7 + 0.726}{14.7}\right)^{0.29} =$$

527.32 *deg. F.*

above absolute zero or

$$527.32 - 460 = 67.32 \text{ deg. } F.$$

above Fahrenheit zero; that is, the inertia compression has warmed the air 7.32 deg. To find the effect this has on the volumetric efficiency the actual weight of the air under these conditions must be found.

To find the weight of air at any pressure and temperature this formula may be used:

$$w = \frac{pv}{53.35\,T}$$

where

w = Weight in pounds;
p = Absolute pressure in pounds per square foot;
v = Volume in cubic feet;
T = Absolute temperature F. degrees.

Since the actual cylinder capacity of the compressor does not enter into this part of the problem, for the sake of simplicity, assume the piston displacement to be 1 cu.ft. Then applying the formula for air at 60 deg. temperature and atmospheric pressure,

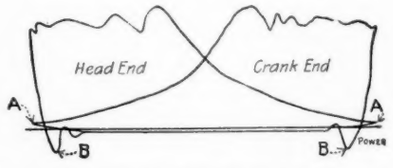
$$w = \frac{14.7 \times 144 \times 1}{53.35 \times (460 + 60)} = 0.076303$$

lb. per cu.ft.

For air at 67.32 deg. and gage pressure 0.726 lb. per square inch,

$$w = \frac{(14.7 + 0.726) \times 144 \times 1}{53.35 \times (460 + 67.32)} =$$

0.07806 *lb. per cu.ft.*



REPRODUCTION OF DIAGRAMS IN FIG. 1 OF MR. REDFIELD'S ARTICLE, SHOWING EFFECT OF AIR INERTIA

The ratio of the volumetric efficiencies of the compressor when using the direct and when using the long intake will be approximately equal to the ratio of the weights of the air in the cylinder at the commencement of the compression stroke. Then, if a volumetric efficiency of 80 per cent. is assumed when the compressor is getting its air direct and calling the volumetric efficiency with the long intake equal to x,

$$\frac{80}{x} = \frac{0.076303}{0.078960}$$

or $x = 82.786$ per cent., thus showing a gain of 2.786 per cent. in favor of the long intake at the head end. At the crank end a similar calculation based on Mr. Redfield's figures shows a gain of 1.86 per cent., making the gain for both ends average about 2.3 per cent.

The question now arises, will an increase of 2.3 per cent. in the volumetric efficiency of the compressor show an appreciable decrease in the power required to drive it? Mr. Redfield admits that the momentum given to the air in the intake must have been obtained from the compressor piston, and this in turn must have received the necessary power from the driving mechanism.

If, then, the inertia effect is as efficient in compressing the air into the cylinder as the piston is in compressing it into the discharge, then as far as the actual air compressing is concerned, the power required per unit weight of air will be neither increased nor decreased by the addition of the long intake. But, since the volumetric efficiency has been increased 2.3 per cent., then to compress the same amount of air the compressor speed can be reduced in proportion, and would reduce the friction loss of the compressor. If the loss by mechanical friction in the compressor is 15 per cent., then a reduction in speed of 2.3 per cent. would save 2.3 per cent. of 15 per cent. = 0.345 per cent. of the total power required to drive the compressor.

This small gain is more than swallowed up by the friction losses in the intake. An examination of the indicator diagrams shown by Mr. Redfield as Fig. 1 will show that the area between the "hook" at B and the atmospheric line is much greater than the area under the toe at A bounded by the atmospheric line, the suction line, and a line drawn from the point A to the atmospheric line. This shows that the power required to get the column of air in the intake in motion is much greater than the power given up by its momentum at the end of the stroke.

The difference between these areas represents the air friction loss through the intake and the suction valves. The excessive drop in pressure at the beginning of the suction stroke shows that a rebound has taken place, and that at the instant of the opening of the valve the air has reversed its flow and is backing out of the intake. This rebound, or outward rushing of the air, can very often be distinctly felt at the outer end of the intake. It is this forward and backward swishing of the air, and the resulting loss through friction and temperature rise that cause the gain to be converted into a loss on the power end.

A. E. MUELLER.

Mayville, Wis.

Coal and Clinkers

I have read Mr. Bailey's article in the Nov. 28 issue and the one by him published some time ago, and, while both are interesting and instructive, I think he lays too much stress on the importance of the fusing point of the ash. It is a hard thing to lay down any rule for determining the clinkering properties of coal by any chemical analysis, as Mr. Bailey has pointed out, and it is logical that the lower the fusing point of the ash, the more clinker there will be formed. However, I claim that the clinkering properties of coal depend almost as much on the conditions under which it is burned as on the fusing point of the ash; that is, under certain conditions almost any coal will form considerable clinker, while under other conditions a coal containing very fusible ash can be burned without difficulty.

Just what makes ashes fusible depends on various constituents, no one of which can be used as a positive indication of fusibility. Certain proportions of lime and silica will fuse very easily, while other proportions of the same elements will make an almost infusible mixture. Anybody familiar with blast-furnace work knows that the chemists figure out the charges of limestone and ore, which contain silica, in order to get a slag of a certain fusibility.

Iron in the lower state of oxidation is a very powerful flux for silica. When iron in this condition comes in contact with the bridge-wall or side walls, it fluxes the firebrick, and forms a hard clinker which sticks to the walls and which it is almost impossible to break off. It must not be understood that a high percentage of iron in the ash is a positive proof of clinkering properties. Several persons, including Mr. Bailey, have shown that the relation of iron to clinker is not positive. If a laboratory is available and an analysis of the clinker can be made, the troublesome factor can be quickly determined.

The formation of clinker has been prevented by various methods; in some cases by mixing lime, limestone or oyster shells in the coal, and in others by adding sand, clay or similar materials, and in still others by mixing two kinds of coal. Again, the admission of steam under the grates or the presence of water in the ashpit has often given good results.

I do not consider the fusing temperature of the ash anything like as important in buying coal as the heat value. By that I mean the temperature as determined in the laboratory. Very few buyers will purchase a coal on specification only without a preliminary trial, and if a coal clinkers badly under trial I would say to reject it regardless of its ash-fusing temperature. As to the heat value, the heat is what coal is bought for, and it necessarily follows that this should be the basis of the selling price.

It is possible that a sample of the ash prepared in the laboratory would have a different fusing point than that which would be produced in the furnace. While in most cases I would consider this improbable, it is not impossible, and the matter would stand investigation.

Further, coals having ash of low fusing point might be such that their burning temperature would be correspondingly low. For example, lignitic coals often have fusible ash but do not often make clinkers as they burn at a low temperature. Conditions might be such that very little clinker would be formed in any case, as, for instance, with a small boiler with a light load, special settings, etc.

Nearly all tests seem to show that the efficiency does not fall to any marked degree unless the clinker is excessive, say, about 50 per cent. of the ash and refuse. However, as a rule, it is impossible to get a high capacity out of boilers when clinkering troubles are experienced. In plants where high peak loads have to be carried for certain periods, even a moderately clinkering coal would be fatal, but many plants which have a moderate, even load could handle the same coal very successfully. A practical test under the conditions required is the only way in which to find whether coal is suitable regardless of all the laboratory determinations. After the requirements have been met successfully the basis of price should be the amount of heat available for steam-making purposes.

JAMES E. STEELY.

Covington, Va.

Broken Valve Crosshead

After reading over the letter of R. A. Cultra, in the Dec. 19 number, I think that I may be able to help him a little.

I am operating a Green engine built about 18 years ago by the Providence Engine Works, Providence, R. I. This engine is a little larger than Mr. Cultra's. I have never had the least bother with excessive wear or nicking of the tappets or toes. We have, however, had some bother with the bolt that holds the two parts of the stem together.

I think that Mr. Cultra would overcome most of his trouble if he would ease off those sharp corners on the valves as he says, "they are as sharp as a knife edge." This knife edge scrapes the oil off, whereas if the edge were eased off the least bit it would give the oil a chance to get between the valve and seat. I have often done the same thing to a piston ring.

My only trouble has been with the steam valves on a Green engine. If the valves got dry or if any obstruction got in the way, the valves would not shut. I remember that once an accident happened to a dashpot and this kept the steam valve open (the closing not being positive but depending on the dashpot). The valve simply stayed open and in no way hurt the stem or the crosshead.

I have heard of links on the exhaust being broken by something getting caught in the valve. I should advise Mr. Cultra to look over the lifting studs (studs screwed into the tops of the valves to limit their lift off the seat), try the valves for side play, and above all ease off those knife edges.

SAMUEL H. WINTERBOTTOM.

Woonsocket, R. I.

Cause of Boiler Explosions

In the issue of Jan. 2, I note an article by D. M. Fraser on "Cause of Boiler Explosions."

I do not believe that air confined in a boiler while steam was being raised therein ever directly caused an explosion. I think it must be supplemented by some other cause to produce the effect, such, for instance, as Lester A. Fitts describes in the same issue under the heading, "Timely Discovery of Serious Lap Crack." If this had not been discovered it would probably have caused an explosion under the impulsion of a very slight shock, as may be caused by the presence of air entrapped in the boiler while getting up steam.

VICTOR BONN.

New York City.

Isolated Plant Owners Responsible

In the Dec. 19 issue, I read the letter under the above head. In some establishments the power division is seriously neglected and very little attempt is made to determine whether the plant is operating as economically as possible. The engineer is not treated in the same way as are other department heads, as the latter are made responsible for the quality and quantity of the goods turned out and are given some say as to the materials used. To men who are capable of doing such work and assuming the responsibility, good wages are paid.

The engineer, on the other hand, is frequently hampered by being required to do his work with men he does not employ and whose scale of wages is not set by him. The coal is bought on the price basis, not on quality. He is often limited in the matter of cost of oil, waste and other materials. He frequently finds it impossible to get the owners to purchase such new machinery or apparatus as will assist him in keeping the plant in its best condition. He is frequently held responsible for the condition of the shafting and belting, besides the operation of

the engines and boilers. Yet, he is not allowed to use his judgment in the purchase of materials.

The first cost is frequently the only cost considered; operating cost is not considered except as it affects him. If his costs run high, he is blamed, and no excuses are accepted. The cause for high costs is frequently the inferior material which the purchasing agent or plant owner or manager purchases, directly against the judgment of the man who is held responsible.

The engineer is not paid in accordance with his responsibility. He is looked upon as merely an engine runner and as a necessary evil, and not as a manager of a most important part of the entire outfit. The owner well realizes that the successful operation of his plant depends upon its engine; but apparently he does not realize that in order to have the engine operating continuously and satisfactorily and have the power cost as low in this department as the operating costs are in any other department, he must pay good wages to his engineer.

Under these conditions, it is easy to see why the isolated plant is frequently taken over by the central station. Therefore, I heartily believe with Mr. Blanchard that the trouble is far more with the plant owner than with the engineer in many isolated plants. But I also believe that it is up to the engineer to do the best he can with the apparatus that is supplied, getting, when possible, additional apparatus and supplying to the plant owner or manager in as much detail as he possibly can the information he is able to collect. Show him from time to time its value and ask for apparatus which will enable him to give still more information, stating the reasons why. Such signs of interest will stimulate the owner and result in increased wages to the engineer and in decreased costs to the owner, and the engineer will be considered an important adjunct to the plant and treated accordingly.

The engineer should be given such information as will enable him to work out from month to month, or even from week to week, the power costs, including the fixed charges, as in many plants they are a very large portion of the power costs. This will also enable the engineer to supply the plant owner with figures to refute the central-station solicitors. It is not uncommon for the central-station solicitor to place a large value upon the initial cost of the plant, sometimes as high as $200 per horsepower, which in most cases is absurd. If the actual figures are known and are always on hand, no such fictitious value can be placed on the plant, and, therefore, the fixed charges cannot be made excessive.

Care should be taken also to determine the amount of power which would ordinarily be required to heat the plant so as to be in a position to state that the heating of the plant costs nothing, which may be true so long as all of the exhaust steam from the engine is used for heating; or that it costs a certain sum as additional steam is required beyond that which the engine can supply.

HENRY D. JACKSON.

Boston, Mass.

Cost of Power in New England Mills

From a casual perusal of the article by H. G. Brinckerhoff, under the above title, published in the issue of Dec. 19 it would appear that "wise men of the East" have discovered an independent steam power plant where the cost of one horsepower is $16.68 per annum, based on 53 working hours per week, and reference is made to a similar plant where, on the same basis, the cost is $14.57 per year.

The figures quoted may or may not represent superior economy compared with the performance of other plants, depending on whether the cost applies to 33,000 ft.-lb. per minute, actually delivered.

The high standing of the designers of the plant described is sufficient guarantee of the excellence of its appointments. But Mr. Brinckerhoff's statements are indefinite and misleading as to the cost per horsepower actually delivered, if the figure quoted for cost per horsepower per annum is based on gross indicated power without an estimate of any kind as to the indicated power lost in transmission and engine friction, and in driving the condenser pump, power-driven pumps, etc., all of which tend to reduce the amount of power actually delivered to the mill.

The author states that "The best electric-power transmission offer was in the neighborhood of $30 per kilowatt delivered on the switchboard in the mill," and that the installation of the independent power plant resulted in "$9140.02 saving per year over buying power, besides getting all heating." He estimates this saving on the erroneous assumption that indicated horsepower required to be developed by the engine in driving the mill must be the same as the electrical horsepower required to be laid on the switchboard, stating further that "In the calculation of difference of cost no reckoning is attempted to include the cost for electric power which would have been paid from the switchboard record for all the electrical losses in the motors and wiring beyond that point. * * *"

If it is assumed that the same actual or brake horsepower would be required for driving the same loads on the jackshafts, whether derived from motors or transmitted by belts from the engine, then the gross power indicated on the engine could not be the same as the electric power required at the switchboard, unless the losses in transforming electric power from the switchboard into actual power laid on the jackshafts were the same as the actual power, laid on the jackshafts by the engine, plus the loss in transmission plus the engine friction and the engine power employed in driving power pumps and other power-plant auxiliaries. Assuming, however, as in the article, that no reckoning is made against the electric drive beyond the switchboard, and that the losses beyond that point amounted to from 12 to 18 per cent. of the power at the switchboard, then, in order for a comparison on a basis of equality between indicated power with electrical power delivered at the switchboard, the author's conclusion could be had only on the hypothesis that such losses by engine power as belt transmission, engine friction, belted pumps and other power-plant auxiliaries, not only amount to less than from 12 to 18 per cent., but that they amount to nothing.

If Mr. Brinckerhoff can obtain data from actual tests which will show the average amount of actual or brake horsepower supplied to the jackshafts of the Fitchburg Yarn Co., and compare that average with the actual cost—which is the logical method of estimating the cost of power used by a manufacturing establishment—the results, judging from the data thus far given, will still reflect credit on the designers of the plant, but the cost per annum, per horsepower delivered, will be considerably in excess of $16.68.

FRANKLIN VAN WINKLE.

Paterson, N. J.

What Means the Dome?

The article and cut in the Dec. 26 issue pertaining to the high dome on a locomotive discovered in the jungle of an abandoned lumber camp in the South interested me. Possibly the reason for the dome was to get dry steam, as undoubtedly the throttle valve is in this dome. One of the handicaps of the large locomotive on trunk lines is the low dome due to lack of head clearance, resulting in wet steam and hence bringing about the necessity for superheaters which are complicated and bulky for a locomotive on which it is necessary to cluster the many attachments to the boiler like barnacles on a ship.

The high dome on this logging engine may have been used to furnish dry steam to a pump or to drive a sawmill engine as on the side of the dome a pipe connection can be seen.

The writer fired locomotive engines in the early eighties, the boilers being about 42 in. in diameter, and the dome was about 48 in. high, which gave good re-

sults with dry steam and minimized the possibility of priming.

With new main-line equipment the boiler is so large that it requires to be placed above the wheels, raising the boiler still nearer to the clearance line, and thus it can be seen that while the size of boiler is increasing that of the dome is decreasing.

JOHN FRANCIS.

Birmingham, Ala.

The Delray Boiler Tests

I noted with interest the results of "Tests of World's Largest Boilers," as given in the abstract of Dr. Jacobus' paper in POWER for Dec. 5. The two series of tests as presented seem decidedly remarkable both for the high efficiency obtained and for the uniformity of evaporative results. The tests show beyond any doubt that these boilers will give satisfactory results under normal working conditions when a varying load is unavoidable.

The expectations of the designers seem to have been realized to a very considerable extent in regard to the reduction of losses per unit of power generated, and the probable better combustion of the fuel supplied, all of which is traceable to the departure from what has been previously considered conventional design for furnace construction. In these boilers the hottest gases are brought into contact with a comparatively small portion of the setting wall and with a large area of heating surface, and in turn the larger portion of the area of the setting wall is in contact with cooler gases. The relatively large volume of the space directly over the fire is also noticeable, where the gases may mix and burn before coming in contact with the boiler tubes.

I do not quite see how so high a rate of combustion is obtained with the draft as shown in the results given.

C. W. BELL.

Scranton, Penn.

Knocking in Air Compressors

The communication of C. R. McGahey about "Knocking in Air Compressors," on page 902 of the issue of Dec. 12, seems to challenge criticism. The knock which occurs somewhere about mid-stroke in "straight-line" compressors is decidedly not "caused by the elastic spring of the air in the air cylinder acting against the steam piston when the steam is expanding, due to the cutoff," and it is not to be cured by changing the cutoff, which should be adjusted to suit the steam pressure and load.

The knock is caused by the reversal of the driving forces which occurs when the steam power becomes less than the air resistance and the flywheel, instead of being driven, becomes the driver. The only thing apparently to be done about it is to keep the main bearings and the connections with as little slack as possible, and especially to have no vertical play between the crosshead and its upper and under slides.

As to the slight difference which may be found in the lengths of the two connecting-rods, these do not generally make any trouble, because the crosshead in this type of compressor is switched in the middle. If your correspondent had taken off both of the connecting-rods and, accidentally or otherwise, had shoved the end of the crosshead forward or backward, he might easily have found a difference of an inch or two instead of the sixteenth of an inch reported.

FRANK RICHARDS.

New York City.

Feed Water Regulators

Some time ago in an editorial the questions were asked, "What is the use of a feed-water regulator? What is the use of keeping the water level constant?"

A reliable regulator protects the boiler and maintains a steam space of uniform volume, thus tending to produce steam of uniform quality. Another point in favor of the regulator is that it tends to maintain the steam pressure under sudden fluctuations of load, although a belief to the contrary seems to prevail among engineers. A sudden increase in the load causes the water level to rise slightly and this in turn causes the regulator to decrease or cut off the feed to the boiler, while a sudden drop in the load causes a depression of the water level and instant action on the part of the regulator to increase the rate of feed to the boiler.

I believe that a good regulator is almost indispensable and that a poor one is a thing from which to steer clear. A few years ago the engineer in one of the large packing houses in the West related the following to me:

"We have 24 boilers equipped with automatic stokers and feed-water regulators. Once, in our refrigerating plant, which adjoins the power plant, an ammonia tank burst, killing one man and driving everyone from the building, and for more than an hour and 40 minutes no one could get into the boiler room. If we had been without feed-water regulators probably nothing could have saved the boiler plant as the stokers kept up a steady fire during that time."

This suggests one point decidedly in favor of feed-water regulators. Admitting the possibility of all machinery to become deranged, it still must be conceded that a device carefully thought out, designed according to established mechanical and scientific principles and constructed of good material is at a critical moment far more reliable than the average man. Yet, all such automatic machinery requires intelligent attention to see that it is kept in working condition so that when the critical moment does come it may not be hindered because of some loose bolt or dry bearing.

Some engineers believe that the automatic regulator causes the firemen or water-tenders to become careless, but my personal experience has led me to believe just the opposite.

I look on the feed-water regulator as a good investment. A good one will usually save from one to four times its costs in a year and the little outlay for it may at some time be the means of saving the plant.

C. L. JOHNSON.

Newark, N. J.

Engineers' Wages

To be a successful engineer, one must have a grounding in the mechanical trades, such as those of the machinist, steam fitter, boiler maker, etc. In any one of these trades alone the pay is more than double that of the average engineer in certain sections of the country.

Take my own case, for example. I have been making a study of engineering now for eight years; I have worked hard and done the best I could for all of my employers and I am getting very poorly paid for it. Now, one might say, "Why doesn't he look for something else at which he can earn more?" This is all well and good, but I like the engineering business best and I know that we will get higher wages soon.

A barber, dentist, bookkeeper, or man of similar calling can learn his business in two or three years and at the end of that time draw a good salary. An engineer has to study almost a life time, and he gets just a common laborer's wages.

Some wonder who or what is responsible for this state of affairs. The answer is, the engineer himself. Engineers should stand up for their rights and demand a standard wage for each class of engineer. What we all want are an eight-hour day and more salary. Then we can do better work.

In some steam plants they hire a couple of good engineers and a lot of common laborers, and put the latter to work around the engines, boilers, etc.; they are paid about $45 or $50 a month. After a month or so these men call themselves engineers and they hardly know a boiler from a water cistern. These are the men who are killing our opportunities. What we want is a good organization, with all of the engineers in the country as members; then we can go out and fight for what we deserve.

HENRY H. CARTER.

Milwaukee, Wis.

Figures for Mr. Fitzgerrell

In the Dec. 26 number, H. S. Fitzgerrell asks for the size of a tank which when placed in a stream running at 6 miles per hour will cause the water to flow out of the pipe which is connected to the end of the tank and extends 50 ft. above the surface of the stream.

According to the laws of hydraulics, the size of the tank will have no effect on the height to which the water will be forced in the pipe as the height of the rise depends wholly on the velocity of the stream or, in other words, the pressure per unit area, and not the total pressure, on the end of the tank.

In this case the pressure in pounds per square foot in the tank will be

$$P = \frac{V^2 62.5}{2g}$$

where

P = Pressure in pounds per square foot;

V = Velocity of stream in feet per second;

g = Acceleration due to gravity = 32.2.

Since the velocity of the stream is 8.8 ft. per second, we have

$$P = \frac{8.8^2 \times 62.5}{2 \times 32.2} = 75.1 \text{ lb. per sq.ft.}$$

This will cause the water to rise $\frac{75.1}{62.5}$ or 1.2 ft., or about 1 ft. 3 in. The water would rise just as high in the pipe if the tank were removed.

The velocity of the stream necessary to cause the water to flow out of the pipe 50 ft. high would be about 57 ft. per second, or 39 miles per hour, neglecting friction.

WILLIAM BRUNKER.

Chicago, Ill.

The apparatus shown by Mr. Fitzgerrell is nothing more than a pitot tube and as such the height to which the water can be lifted is equal to a constant multiplied by the square of the velocity in feet per second and divided by 2g. The constant varies from 1 to 2, and for a tube of the shape shown it would be very near to 2. In this case the velocity of the water is 6 miles per hour or 8.8 ft. per second. The solution would be as follows:

$$h = k\frac{v^2}{2g} = 2\frac{(8.8)^2}{64.4} = 2.4$$

from which it would appear that the maximum height to which the water could be lifted would be 2.4 ft.

If a place could be found having a fall of a few feet, a hydraulic ram would be the cheapest and easiest means of raising the water to the desired height.

W. L. DURAND.

Brooklyn, N. Y.

The height to which the water will rise depends on the pressure per square inch at the lowest part of the tube, which in turn depends on the rate of flow at that point, or

$$V^2 = 2GH$$

$$H \quad \frac{V^2}{2G}$$

In other words, H equals the height through which a body must fall to attain a speed of V ft. per second, neglecting all friction. A velocity of 6 miles per hour = 8.8 ft. per second.

$$H = \frac{8.8 \times 8.8}{2 \times 32} = 1.2 \text{ ft.}$$

The height to which the water in the tube will rise is independent of the size of the tank, and will stand only 1.2 ft. above the surface of the river at the given rate of flow. A check valve is of no use whatsoever.

D. FLIEGELMAN.

Holyoke, Mass.

To solve this problem we may use the well known formula,

$$\text{Kinetic energy} = \frac{WV^2}{2g}$$

and for convenience we will assume 1 lb. to represent W, the weight of water. The water is flowing at the rate of 6 miles per hour, which is equivalent to 8.88 ft. per second, the value of V. The acceleration due to gravity or g equals 32.2. Then,

$$\text{Kinetic energy} = \frac{1 \times 8.88^2}{2 \times 32.2} = 1.2 \text{ ft.-lb.}$$

Consequently, 1 lb. of water flowing down the river at a speed of 6 miles per hour would have a kinetic energy of 1.2 ft.-lb., and 1 lb. raised vertically 1.2 ft. would require 1.2 ft.-lb. Therefore, the water would rise 1.2 ft. in the 2-in. pipe in the case under discussion. Friction has been neglected in the foregoing.

The size of tank and the check valve have nothing to do with the problem.

J. C. CALLERY.

Hamilton, Ohio.

Neglecting the losses due to friction, eddies, etc., the height to which the water will rise may be calculated from the formulas for falling bodies,

$$t = \frac{v}{g} \text{ and } H = \frac{g}{2}t^2$$

in which

H = Height to which the water will rise;

t = Time in seconds;

g = Acceleration due to gravity = 32.16;

v = Velocity in feet per second.

The stream flowing at the rate of 6 miles per hour gives a velocity of 8.8 ft. per second; therefore,

$$t = \frac{v}{g} = \frac{8.8}{32.16} = 0.27 \text{ sec.}$$

Substituting,

$$H = 16.08 \times 0.27^2 = 1.17 \text{ ft.} = 1 \text{ ft. } 2 \text{ in.}$$

In actual practice the height would be considerably less, owing to various losses.

H. A. MUNYAN.

Syracuse, N. Y.

[Additional contributions on this subject were received from L. Johnson, J. Hart and O. Kuhneman.—EDITORS.]

Christie Air Steam Engine

In the Dec. 19 issue, George L. Sullivan mentions making a report to one of his clients on the Christie engine. His conclusions are undoubtedly correct and are admirably summed up in his last paragraph, but how he arrives at any conclusion at all, with his manner of reasoning, is more than I can understand.

He says: "When the steam valve opens, the boiler, steam pipe and engine cylinder become one vessel and a rapid diffusion of the air takes place into the steam pipe." If this statement were correct, it would put all gas and gasoline engines into the scrap-pile, for when the inlet valve opens the cylinder and the open air "become one vessel" and the diffusion would fill the engine room with dangerous vapors.

If the air were to diffuse into the steam pipe, there would be no harm done; in fact, I imagine an ordinarily good engineer, with plenty of horse sense, in designing an air-steam apparatus would use a common air compressor and pump the air into the steam space in the boiler or into the steam pipe. This would serve to keep condensation out of the steam pipes as well as the engines connected with them.

Mixing steam and air together does not change their pressure or temperature. If pure steam has to be expanded to a complete vacuum to get all of the work out of it, then the air-steam mixture will not give up all of its energy with a less expansion. The only advantage of mixing air with steam is the lowering of the saturation point, which prevents condensation in the cylinder. This is a great advantage and well worth considering, but this same lowering of the saturation point makes it impossible to use a condenser unless some new system of condensing be discovered—possibly some kind of absorption system similar to that used in ice making would do the work.

Of course, the promoters appear to prove that the air-steam is exhausted into the open air at a much lower pressure than the air itself, but this is true only in a technical sense. The same line of reasoning from Dalton's law would show that the pressure of the open air is much lower than it actually is, for the air is a mixture of several gases, and is not the pressure of each gas the same as it would be were there no other gases in existence?

FRED BOONE.

Davidson, Okla.

Inquiries of General Interest

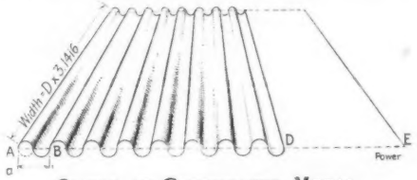
Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Heating Surface of Corrugated Flues

How is the factor 4.93 obtained in the rule to determine the heating surface of corrugated flues?

F. A.

Supposing the flue to be cut horizontally and straightened out as shown in the illustration, there would be a sheet of corrugated metal the width of which would be the mean circumference of the tube; that is, the mean diameter times 3.1416. Each corrugation is practically



SHEET OF CORRUGATED METAL

a half circle to either side of the mean diameter so that the length of the sheet from *A* to *B* is equal to the circumference of the dotted circle in the illustration. The length that it actually occupies in the corresponding length of a flue is *ab*. The length of the flattened sheet is therefore to the length of the tube as 3.1416 is to 2, or the length *AE* of the straightened sheet would be

$$\frac{3.1416 \times L}{2}$$

where *L* equals the length *AD* of the corrugated flue. Since the surface is the length multiplied by the width, the area is

$$\frac{3.1416 \times L}{2} \times D \times 3.1416 \text{ or } \frac{3.1416^2\ DL}{2}$$

$$= 4.93 \times \textit{diameter} \times \textit{length}$$

Resistance of Copper Wire

Two wires contain 100 cu.in. of annealed copper; one is a round wire 0.5 in. in diameter and the other is square, 0.5 in. on a side. Which wire has the greater resistance?

C. E. N.

The round wire has the greater resistance because its cross-section is smaller, and its length must be greater for the same weight. The cross-sectional area of the round wire is 0.19635 sq.in., and its length would be

$$\frac{100}{0.19635} = 509.3\ in.$$

The cross-section of the square wire would be

$$0.5 \times 0.5 = 0.25 \text{ sq.in.}$$

and its length would be

$$\frac{100}{0.25} = 400\ in.$$

long. The resistance of a soft copper rod 1 sq.in. cross-section is about 0.00000069 ohm per inch of length. To determine the resistance in ohms of a copper conductor, multiply the quotient of the length divided by the cross-section in square inches by 0.00000069. The resistance in ohms can also be determined by multiplying the quotient of the volume in cubic inches divided by the square of the cross-section in square inches by 0.00000069. Thus the resistance would be:

For the round conductor

$$\frac{509.3}{0.19635} \times 0.00000069 = 0.0017897\ ohms$$

For the square conductor

$$\frac{400}{0.25} \times 0.00000069 = 0.001104\ ohms$$

Substituting figures to the second rule, it would be thus expressed:

For the round conductor

$$\frac{100}{0.03855334} \times 0.00000069 =$$

$$0.0017897\ ohms\ nearly$$

For the square conductor

$$\frac{100}{0.0625} \times 0.00000069 = 0.001104\ ohms$$

Feed Water Heaters

What is the difference between an open and a closed feed-water heater?

H. H.

An open feed-water heater is one in which the steam and feed water mingle, and the steam in condensing gives up its heat directly to the water. Closed heaters are those in which the steam and water are in separate chambers, and the steam gives up its heat to the water by conduction.

Lap of Corliss Engine Valves

Why is lap given to the steam valves of Corliss engines?

A. K. L.

If the eccentric could be run at right angles with the crank, only sufficient lap to insure the valves being tightly closed would be necessary. To get a sufficiently early opening for release and closure for compression, the eccentric must be advanced; this would pull the steam valve open before the crank got to the center, and enough lap is added to cover the port until the desired lead is obtained.

Throttling and Automatic Governors

What is the difference between a throttling and an automatic governor?

H. H.

A throttling governor regulates the speed of the engine by changing the steam pressure as it enters the cylinder, in accordance with the load. An automatic governor regulates the speed by cutting off the supply of steam at various points of the stroke, in accordance with the load and pressure. With a throttling governor, the volume of the steam is constant and the pressure varies. An automatic governor permits the steam to enter the cylinder at the highest available pressure, and the volume is varied to meet the requirements of the load.

Braces for Boiler Head

How many braces 1 sq.in. cross-section would it take to brace a 60-in. boiler for 80-lb. pressure, where the top row of tubes is 5 in. above the center?

A. W. T.

Assume a space 2 in. wide above the tubes and 2 in. wide around the edge being supported by the tubes and flange. The height of the circular segment to be braced would be

$$30 - (5 + 2 + 2) = 21\ in.$$

The diameter of the circle of which it is a part is

$$60 - (2 \times 2) = 56\ in.$$

therefore, the area to be braced is 843.61 sq.in. The pressure on the surface would be

$$843.62 \times 80 = 67{,}489.60\ lb.$$

If one brace sustains 6000 lb., it will take

$$67{,}489.60 \div 6000 = 11.2 \text{ or } 12\ braces.$$

Effective B.t.u. in Producer Gas

What are the effective B.t.u. in producer gas and how are they to be found?

C. B. S.

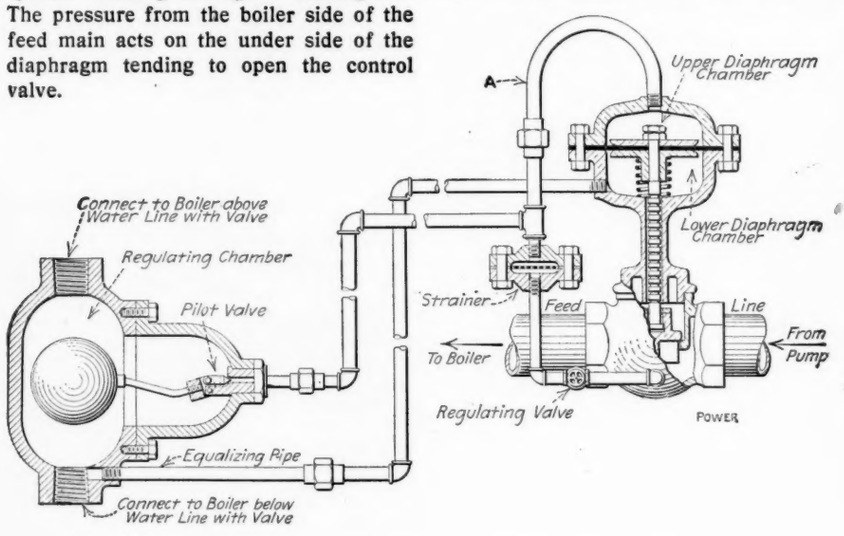
The effective heat value is equal to the total heat units per cubic foot minus the heat units that will be carried off in the steam made from the hydrogen in the gas when the latter is burned. This heat is usually deducted by considering that the available heat liberated by combustion of the hydrogen in the gas will be only 51,700 B.t.u. per pound of hydrogen instead of the full value of 62,000 B.t.u.

New Hydrostatic Feed Water Regulator

Some weeks ago we published an editorial on feed-water regulators. We pointed out that it was highly desirable that the flow of water to the boiler be not entirely interrupted.

The "Watch Dog" feed-water regulator here described is so designed that the feed-water flow is never entirely cut off except when the boiler is delivering practically no steam. The principle upon which it operates may be discerned by referring to the accompanying figure.

For water to flow to the boiler it is necessary that the pressure in the feed main on the pump side of the controlling valve be slightly higher than on the boiler side. In the "Watch Dog" regulator a diaphragm is attached to the disk of the control valve by means of a spindle working through a stuffing-box. The pressure from the boiler side of the feed main acts on the under side of the diaphragm tending to open the control valve.



THE "WATCH DOG" FEED-WATER REGULATOR

The pressure in the pipe *A* acts on the upper side of the diaphragm, tending to close the valve. This pressure depends upon the pilot valve which is controlled by the float. As the pilot valve approaches the closed position, the pressure on the upper side of the diaphragm approaches that in the pump side of the feed main, over-balances the pressure on the under side of the diaphragm and causes the control valve to close slightly and reduce the rate of flow to the boiler. As the float falls the pilot valve is opened a little wider and the opposite results are produced.

The claims made for this regulator may be summed up in the four words, efficiency, reliability, simplicity and durability.

The L. J. Wing Manufacturing Co., West and Albany Sts., New York, manufactures the "Watch Dog" feed-water regulator.

Sauer Adjustable Shaft Bearing

An adjustable shaft bearing which provides means for compensating for wear and insuring a proper alignment of the shaft by using a set of bearing members or blocks adjustable in a radial direction has been placed on the market by the Sauer Power Generating Co., 5115 to 5119 Rosetta St., Pittsburg, Penn.

The special advantages claimed for this bearing are simplicity of construction, easy adjustment of center and side motions while running and the elimination of liners, oiling grooves and shaving or fitting. Fig. 1 is a view of the bearing ready to be placed on the shaft.

The bearing consists of a casing or shell suitably supported and a sleeve having several slots fits loosely around the shaft. The bearing blocks are inserted in these slots, as shown in Fig. 2, to slide freely therein and be adjustable relative to the shaft. At one end of the shell a thimble is placed between it and the bearing block and the engaging surfaces between these three parts are so arranged that the distance between the blocks and the shafts is regulated by the position of the thimble.

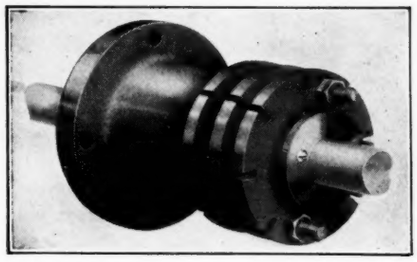


FIG. 1. ADJUSTABLE SHAFT BEARING

The preferred construction is to make the bearing blocks wedge-shaped with their outer faces at an angle to the axis of the shaft, rounded and tapering toward the end of the shell engaging the thimble. The bore of the thimble, shown by the dotted lines in Fig. 3, is tapered to correspond to the outer faces of the bearing blocks. This thimble is threaded externally and the bearing shell internally so that the threads engage, and by

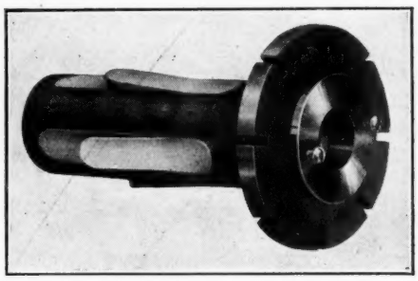


FIG. 2. TAPER SLEEVE WITH BEARING BLOCKS IN PLACE

rotating the former the bearing blocks are adjusted accurately to insure a proper engagement with the shaft and to compensate for wear. To turn the thimble more conveniently an annular flange *B*, Fig. 4, is provided at its outer end, enabling the thimble to be engaged with a spanner or wrench.

The threaded ring *A* set on the thimble

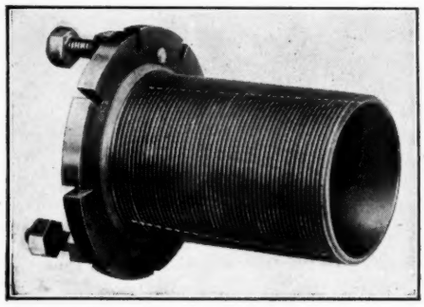


FIG. 3. THE THIMBLE BORE SHOWN BY DOTTED LINES

can be used to screw up against the end of the shell after the thimble has been adjusted as a locknut to prevent displacement. Another means provided for locking the thimble consists of the annular flange *C* on the end of the sleeve

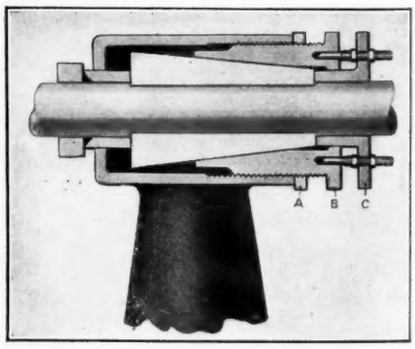


FIG. 4. SECTIONAL VIEW WITH BEARING IN PLACE

surrounding the shaft through which a number of bolts pass. These bear against the flange *B* on the end of the thimble and are held in place by nuts on each

side of the flange, which serve to force the bolts against it and lock them in place.

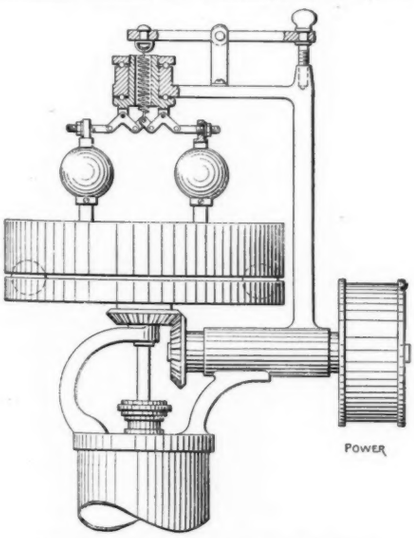
At the opposite end of the shell there is an annular flange extending inwardly and fitting on the sleeve surrounding the shaft. The space inclosed by this flange is utilized for storing oil to lubricate the bearing, and this may be fed into the chamber from a tank through a pipe tapped in the shell of the bearing. The oil passes from this space to the shaft through apertures in the portions of the sleeve between the bearing blocks, which are clearly shown in Fig. 2. Drippings of the lubricating oil may be drawn off from the bottom of the shell by another pipe and fed back into the tank by a pump or other device of this nature.

In use the center adjustment is secured by loosening the locknut *A* and turning the inside tapered sleeve or thimble in Fig. 3 as the running fit requires. To adjust the side motion the nuts on the flange of the sleeve *C* are tightened. The only wearing parts of the bearing are the adjustable blocks shown in Fig. 2, which are made either of babbitt metal or bronze.

As side friction on the bearing wears only one block at a time, it is possible by turning the sleeve to have all the blocks successively assume the position of greatest wear and wear them all down equally. New blocks can be easily set in position when the old ones wear out, as no special skill is required.

Governor Tension Adjusting Mechanism

Patents have recently been granted to Charles Grant, of Wilmington, Del., on



GOVERNOR AND TENSION-ADJUSTING MECHANISM

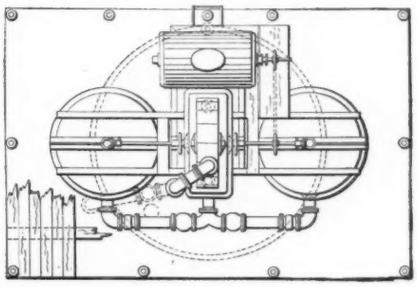
a governor tension adjusting mechanism, the design of which is shown in the accompanying figure.

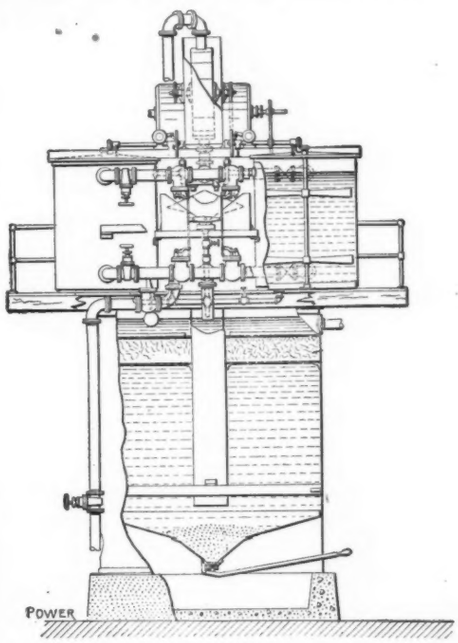
The centrifugal force developed by the revolution of the ball weights is counteracted by a spring connected to the weights by a set of links and bell-cranks. The bell-cranks are supported by a hollow ball bearing supported by an arm from the base as shown. The spring passes through the hollow center of this bearing and is attached by a swivel to one end of an adjusting lever.

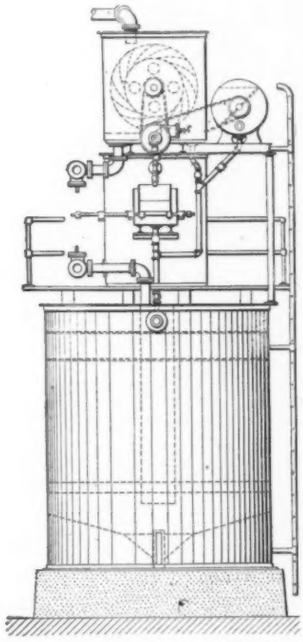
The tension of the spring may be adjusted while the governor is in motion by the simple process of manipulating the thumb-screw at the other end of the lever.

An Automatic Water Purifying System

The purification of water for boiler-feed and industrial purposes is quite essential in many plants. There are numerous machines and devices on the market for this purpose and the selection of one for any particular case is largely a matter of the cost of installation and operation.







THE LORD COMPANY'S AUTOMATIC WATER-PURIFYING APPARATUS

The George W. Lord Co., Philadelphia, Penn., has recently put on the market an apparatus for water purifying which is entirely automatic in its operation and which may be installed for a comparatively moderate price. The apparatus consists principally of one large settling and filtering tank, two mixing tanks, one chemical storage tank and two measuring chambers.

The incoming water first passes over a waterwheel which furnishes the power to operate paddles in the mixing tanks and chemical storage tank. From the wheel the water flows to either one or the other of the two mixing tanks directly below, where it comes in contact with the chemicals flowing by gravity from the chemical storage tank. The solution of chemicals is measured out by an automatic measuring valve and the speed of operation varies with the flow of the water. Hence, the correct amount of chemicals is mixed with the water no matter what the rate of flow may be.

From the mixing tanks the water flows to the bottom of the settling and filter tank through a large cylindrical tube, where it drops the bulk of the precipitates formed into a cone-shaped hopper bottom of the tank. These precipitates can be removed by a sludge valve designed for this purpose. The water then rises and after passing through an excelsior filter near the top of the tank flows off through the outlet pipe at the top.

The inlet and outlet pipes of the two mixing tanks are controlled by lever valves which are automatically operated so as to cause the water to flow first into one and then into the other of the tanks. These valves, as well as the chemical measuring valve, are operated by means of sets of levers which are shifted by a dumping bucket, the latter operated by the weight of water run in from overflow pipes.

A float valve in the inlet pipe, operated by a float in the filtering tank, controls the entire operation of the apparatus.

Locking Device for Canton Shaking and Dumping Grate

The Canton shaking and dumping grate, which is manufactured by the W. H. Allman Co., Canton, Ohio, is shown in Fig. 1, which also illustrates the quadrant that provides a means for locking the grate members in a smooth, even position, as shown on the near side.

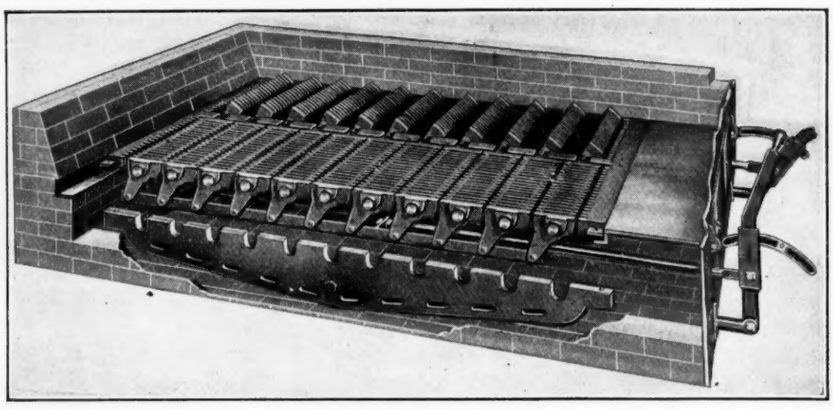


FIG. 1. GRATES IN A LOCKED AND OPEN POSITION

The grate sections are operated by a horizontal rod which is attached to a projection extending from the shaking-rod connection. The shaking-arm in the front of the furnace is made hollow to receive a hand lever. This lever is made as shown in Fig. 2 and has a projection on one side at the end. A curved piece having shallow recesses cast on one side is attached to the furnace front and passes through a suitable hole in the head of the shaking-arm. This serves as a guide to the arm when operating the grate and also as a locking member.

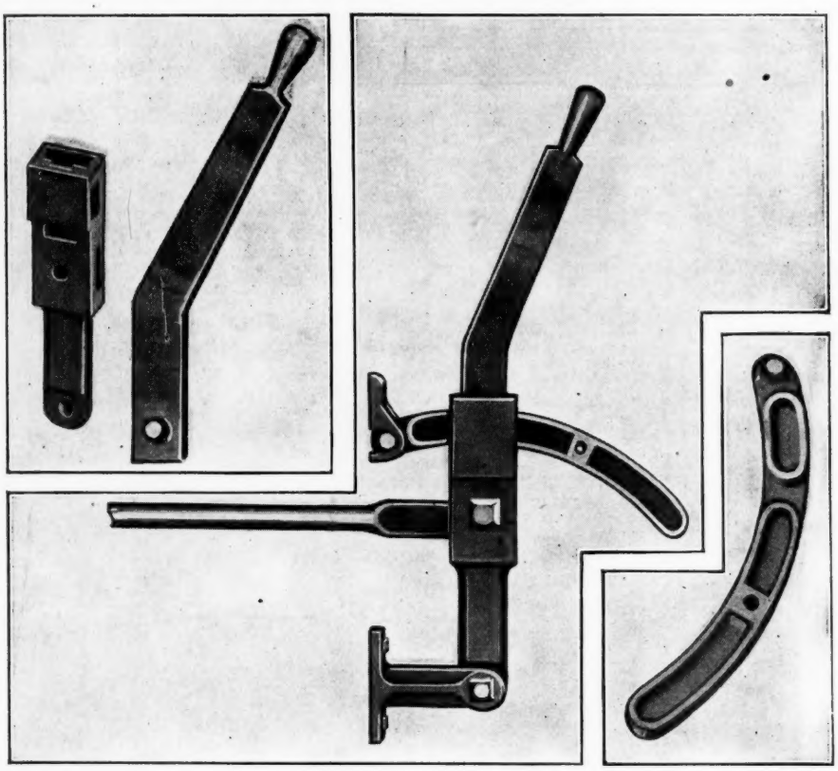


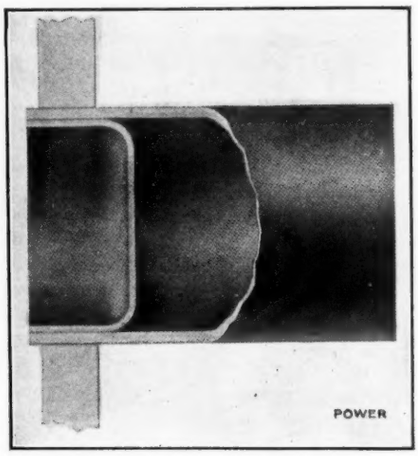
FIG. 2. DETAILS OF THE LOCKING DEVICE

Between the shoulders formed on one side of the curve piece there is an opening. When the grates are flat, the boss on the shaking handle will pass down through this opening until it is in a position to slide along the bottom of the curved member. The grates can then be shaken. A pin in the curved member prevents the grate from being dumped when shaking the fire. Removing the pin permits the grate to be dumped by pulling the lever to its extreme travel.

Before the shaking lever can be removed from the head of the shaking-arm, it must be pushed forward to its extreme travel, when the grates will be level and in their proper position. Then the shaking lever can be removed, but not before. With this arrangement a careless fireman cannot leave the grate partly closed with the ends sticking up in the fire and unburned fuel falling into the ashpit.

Minute Emergency Expansion Plug

The Max Machine Co., Clinton, Mass., has recently placed on the market an emergency plug for plugging the ends of tubes in return-tubular boilers, in case they suddenly give out, thus permitting the boiler to be kept in service until opportunity permits of a permanent repair.



MINUTE EMERGENCY EXPANSION PLUG

These plugs are made in four sizes, which vary about $^{10}/_{1000}$ in. in diameter, to accommodate the difference in the diameter of the tubes. When a tube leaks a pair of plugs are selected which will drive hard in the ends. They are inserted as shown in the accompanying illustration. Should the plug leak it can be made tight by peening with a hammer.

Rotary Gate Valve

For lack of room it is frequently impossible to use the straight gate valve where conditions of service make its use desirable. In such an event the Rothchild rotary-gate valve, which is illustrated herewith, might be the solution to a bothersome problem, not that economy of space is the only feature which this valve has to recommend it.

The Rothchild rotary-gate valve is an angle valve, the feature of which is two concentric cylinders, one of which is stationary, forming the seat, and the other revolving, forming the gate. When the ports in the two cylinders are in line the gate is open and the fluid passes through the gate in the direction of the arrow shown on the side of the body. To close the valve, the gate or outer cylinder is

revolved 90 degrees, thus covering the ports in the seat.

The gate is cut into halves to admit of the fluid in the valve exerting sufficient pressure between the gate and the seat to prevent leakage. When the two halves of the gate are fitted over the seat there is a gap of ⅛ inch between the two halves to prevent them from touching each other and thus insuring a good bearing between the gate and the seat.

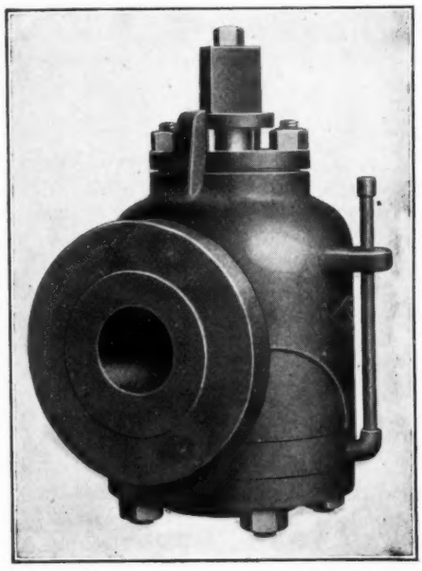


FIG. 1. ROTHCHILD ROTARY GATE VALVE

The fork for operating the gate engages the lugs shown on each half and exerts only sufficient pressure on the gate to insure its always being in contact with the seat, whether the valve is open or shut. On top of the stem there is a nut on which the operating lever is fitted. This nut also has a heavy lug on it which strikes the lugs shown on

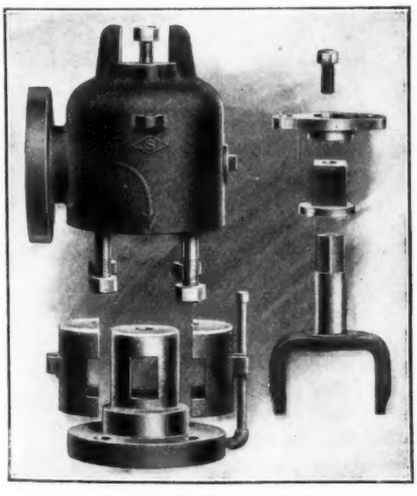


FIG. 2. DETAIL PARTS OF VALVE

the body of the valve to indicate that the valve is wide open or shut. The collar or boss on the fork is, of course, ground tight with the under surface of the gland.

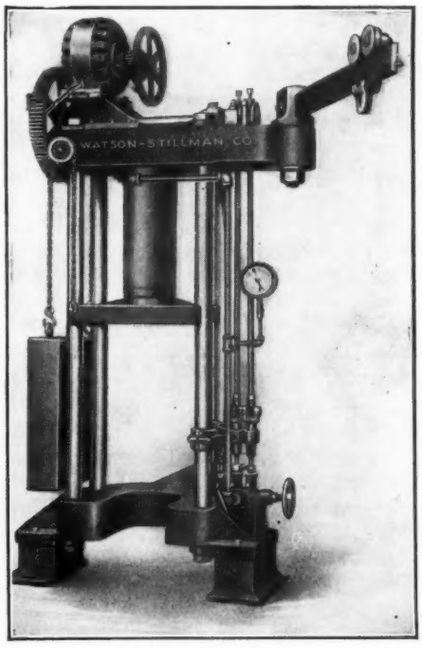
The small pipe tapped into the flange of the valve seat is for forcing lubricant, by means of a compressed grease cup, along a groove on each side of the seat. It is obvious that this valve cannot be jammed shut or open. This construction provides such an exceptionally large bearing surface between the gate and the seat that the amount of cutting necessary to make it leak is proportionally greater than with valves having smaller bearing surfaces.

The working parts of this valve are unaffected by any of those strains in the piping which tend to distort the body of the valve and in time produce leakage. These valves remain tight under the most unfavorable conditions and are particularly valuable for boiler-blowoff service when a leaky valve is not only troublesome but also a source of loss of much energy.

The Rothchild rotary-gate valve is manufactured by the John Simmons Company, 110 Center street, New York City.

Hydraulic Press

The hydraulic press illustrated herewith is useful for broaching, keyseating, putting gears on shafts, pressing bearings, handling mandrels and general work where heavy pieces are to be forced together.



HYDRAULIC PRESS

A crane bracket and beam are extended from one end so that the work may easily be swung into the press. A back-geared motor mounted upon the pedestal on top of the press drives the pump shaft. Upon the other end of this shaft are two pump eccentrics. The pump pistons are both ¾ in. in diameter by 2 in. stroke. The pedestal legs act as a reservoir for the pump.

The operating valve shown is a single-screw stem valve which releases the pressure from the work when open and starts the ram down when closed. A safety valve is used in connection with the pump to stop dangerous overload. The press is made in two sizes, 80 and 100 tons capacity respectively, and is also made hand or belt driven. This press is built by the Watson-Stillman Co., 50 Church St., New York City.

Power System of the Brakpan Mines, Ltd.

BY S. R. STONE

An interesting example of the application of modern scientific methods to regulation of the power consumption of a mine and ore-reduction plant is afforded by the arrangements recently completed on the property of the Brakpan Mines, Ltd., near Johannesburg, South Africa. Here power is purchased from the Victoria Falls & Transvaal Power Co., which in turn buys the surplus water from the shafts; and a close check is kept upon the rate of current consumption in each part of the plant by means of separate metering. This enables the management to ascertain whether the use of power at any point is excessive and to determine, through experimental changes, where economies can be effected.

All of the equipment in or about the mine and ore-reduction plant is electrically operated, the division of motors being about as follows: mine pumping, 1500 hp. or less; underground haulage and surface tramming, 400 hp.; hoists, 4500 hp.; crushers, stamps, tube mills, etc., 2200 hp.; mill and cyanide-plant pumping, 1000 hp., and the remainder for various minor purposes. The total estimate of motors required for operation at the full capacity planned approximates 10,000 hp., but the allowance made for this has been liberal and the actual current consumption in regular service is low. At the same time there is sufficient steadiness of operation to insure good power and load factors. The current is transmitted to two transformer and converter stations, one at each hoisting shaft. Distribution is at 2100 and 500 volts, according to the character of the service, all lines being carried as underground cables, of the paper-insulated, lead-covered, armored type. For the most part, these are laid and connected on the ring system, enabling the supply to any part to be maintained in case of individual breakdowns or any part to be isolated when necessary without interruption to the rest of the service. There is a very extensive lighting system, both above and underground. Of the three electric hoists installed, two are supplied through flywheel motor-generator sets, on the Ilgner system, with Ward Leonard control, and one is driven without any balancing apparatus, from an alternating-current motor with external resistance for speed variation. The capacity of each hoist is stated as 100 tons per hour, based on a vertical depth of 3800 feet.

A Correction

In the description of the Burt induced-draft ventilator, on page 134 of the Jan. 23 issue, the address of the Burt Manufacturing Co. was inadvertently given as Cleveland instead of Akron, Ohio. The error will, of course, be recognized by many of our readers, and we trust that the above correction will reach those who are not familiar with the address of the company in time to avoid any serious confusion or inconvenience.

Water Power Development Utilizing a 2985-Foot Head

The *Engineering News* for Dec. 28, 1911, contains an interesting description of the Adamello water-power development which supplies power to the city of Milan, Italy. The water supply is taken from the rivers Oglio and Paglia and Lake d'Arno, all of which are fed from the glaciers of the Adamello Mountains, and is led to two power stations, one at Isola and the other at Cedegolo.

The distinguishing feature of the system is the extremely high head, 2985 ft., under which the Isola station operates. In order to have the necessary water-carrying capacity with minimum loss of head, and yet provide adequate strength without making the pipe thickness unduly large, it was decided to lay two parallel supply-pipe lines to the power house. The top section of these pipe lines from the penstock to a point where the static head reaches 722 ft. consists of riveted pipes 31.5 in. in diameter with walls 0.28 to 0.55 in. thick. The next section of the line consists of lap-welded pipes with double-riveted sleeve joints; and the final section near the power house at which point a minimum diameter of 22 in. is reached, is made up of lap-welded pipes 1.26 in. thick with welded-on flanges recessed to receive rubber packing. Before putting these pipes into place they were subjected to a pressure of 4000 lb. per square inch, or about three times the working pressure.

Each pipe delivers 35.3 cu.ft. per second and the total loss of head is only 79 ft., or about 2.6 per cent.

The turbines are each fed by a single jet, and regulation is effected by means of a deflecting nozzle connected with the governor. A pear-shaped needle within the nozzle regulates the area of the opening and the quantity of water required for the turbine. Should a large reduction in load occur suddenly, the governor causes the nozzle to swing so that the jet clears the bucket. The regulator then begins to close the opening by means of the needle and to swing the nozzle back. In this way, any shocks incident to a sudden change in load are averted.

The Isola station is laid out for seven 6000-hp. turbines running at 620 r.p.m., although at present only five are installed. Each is direct-connected to a three-phase, 40-cycle, 12,000-volt generator from which current is delivered to the Cedegolo station, where it is stepped up to 60,000 volts for transmission to Milan.

The Cedegolo station is similar in many respects to the Isola station, but utilizes a head of only 1542 ft.

A Swedish Hydro-electric Power Station

Engineering, of Dec. 22, publishes a description of the Gullstang hydro-electric power station in Sweden. Francis double-flow turbines are used under an effective head of 20 m. (about 66 ft.).

Running at 250 r.p.m., the 4000-hp. units have a guaranteed efficiency of 79 per cent. at full load, 78 per cent. at three-quarters load and 72 per cent. at half load. The 4500-hp. unit has a guaranteed efficiency of 78, 79 and 72 per cent. respectively at the loads above mentioned. For each per cent. that the efficiency is short of the guarantee the manufacturers agree to pay a penalty of 2000 kr. ($536) per turbine, and for each per cent. by which the efficiency exceeds the figures of the guarantee, the manufacturers are to have a premium of 1500 kr. ($402) per turbine.

The turbines are actually run at 265 revolutions. The cost of installation, based upon the three 4000-hp. and one 4500-hp. units already installed, is 192 kr. ($51.46) per horsepower installed, and 265 kr. ($71.02) exclusive of reserve. When the station is fully completed it is expected that the cost will be reduced to 138 ($36.98) and 167 ($44.76) kr. respectively.

Increase in Oil Production

The production of petroleum in 1911 increased slightly over the record-breaking figures of 1910. The following table gives a comparison of the final figures of the United States Geological Survey for 1910 and the estimated output for 1911:

PRODUCTION OF PETROLEUM IN 1910 AND 1911

	1910 Barrels	1911 Barrels
Appalachian field..	31,985,515	28,000,000
Louisiana	6,841,395	10,000,000
Kansas and Okla..	53,157,386	56,000,000
California	73,010,560	81,000,000
Texas	8,899,266	9,000,000
Miscellaneous	35,661,926	33,000,000
	209,556,048	217,000,000

The total production for the United States is between 215,000,000 and 220,000,000 bbl. The gain in a single state—California—was greater than the net gain shown for the country as a whole.

The tendency to substitute oil for coal in many industrial establishments is growing rapidly. It is further encouraged by the possibilities of still greater economies by burning oil in internal-combustion engines. It has been adopted by the navy and its use increases on the railroads. Oil is being taken seriously.

Detroit Convention of Marine Engineers

The National Marine Engineers' Beneficial Association held its thirty-seventh annual convention at Detroit, Mich., during the week commencing Jan. 15. About 100 delegates were in attendance, representing associations from Seattle, Wash., to Portland, Maine, and from the Lakes to the Gulf.

The convention was called to order at the Tuller Hotel by National President William F. Yates at 10 o'clock on Monday morning. After a brief address, the committee on credentials was appointed by the president and the customary preliminary business was proceeded with. Mayor William B. Thompson then made the address of welcome. President Yates responded, thanking the mayor for his courtesy.

The social features included several theater parties and visits to the local plants, the main event being a smoker, which was attended by many of the prominent engineers of Detroit.

The following national officers were reëlected: William F. Yates, New York, president; David W. Miller, Seattle, first vice-president; George W. Bowen, Port Huron, second vice-president; Charles N. Vosburgh, New Orleans, third vice-president; George S. Grubb, Chicago, secretary; Albert L. Jones, Detroit, treasurer; William S. Brown, Edwin P. Groff, Frank J. Houghton, advisory board, and James J. Waters, trustee.

The supplymen's association connected with this convention elected F. E. Romsley, president; Charles Heitzman, vice-president; C. A. Wilhoft, secretary-treasurer.

The next annual meeting will be held at Charleston, S. C., next January.

I. O. E. Class in Plant Management

A series of discussions on plant management will be given by the Institute of Operating Engineers, 29 West Thirty-ninth St., New York City, on the first Tuesday of each month, at 8 p.m. The program is as follows:

Feb. 6. "Plant Records," Prof. W. D. Ennis, Polytechnic Institute.

March 5. "Employer and the Operating Engineer," F. R. Low, editor POWER.

April 2. "Systematic Inspection," H. E. Collins, secretary of the Institute.

May 7. "Fire-room Methods," E. G. Bailey, mechanical engineer, Boston, Mass.

June 4. "Handling Men," Willis Lawrence, chief operating engineer of the

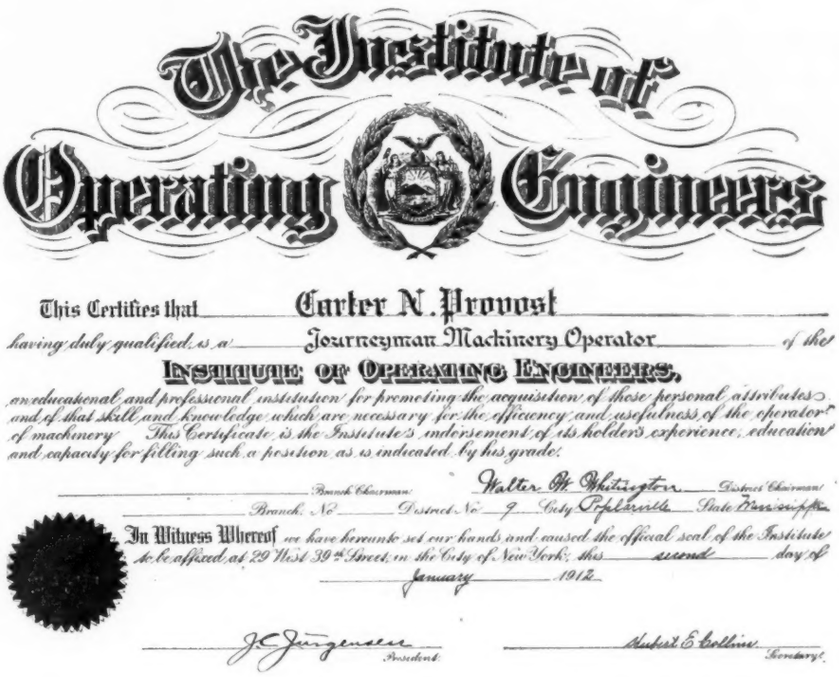
Interborough Rapid Transit, New York City.

July 2. "Essential Principles," J. C. Jurgensen, president of the Institute.

These discussions are open to the public.

The Institute Issues Its First Certificate

Carter N. Provost is the recipient of the first certificate issued by the Institute of Operating Engineers. The grade is that of journeyman machinery operator.


The Institute of Operating Engineers

This Certifies that Carter N. Provost

having duly qualified as a Journeyman Machinery Operator of the

INSTITUTE OF OPERATING ENGINEERS,

an educational and professional institution for promoting the acquisition of those personal attributes and of that skill and knowledge which are necessary for the efficiency and usefulness of the operator of machinery. This Certificate is the Institute's indorsement of its holder's experience, education and capacity for filling such a position as is indicated by his grade.

Branch Chairman Walter H. Whittington District Chairman

Branch No. District No. 9 City Poplarville State Pennsylvania

In Witness Whereof we have hereunto set our hands and caused the official seal of the Institute to be affixed at 29 West 39th Street, in the City of New York, this second day of January 1912.

J. C. Jurgensen President Robert E. Collins Secretary

The applicant must be 21 years of age or over and must have served a regular apprenticeship to the machine, electrical or allied trades or have held positions either as machinery operator or fireman for at least 5 years. A reproduction of the certificate is presented herewith.

SOCIETY NOTES

Preparations are under way for the annual banquet of the Pittsburg Section, American Institute of Electrical Engineers, which will be held in the English room of the Fort Pitt Hotel, Saturday evening, Feb. 17. The banquet committee, of which K. C. Randall is chairman, announces that L. A. Osborne, vice-president of the Westinghouse Electric & Manufacturing Co., will act as toastmaster. The guest of honor and principal speaker will be Gano Dunn, of New York, president of the American Institute of Electrical Engineers. Other speakers will be Director A. A. Hamerschlag, of the Carnegie Technical Schools, and Henry E. Longwell, consulting engineer with the Westinghouse companies. The invitations include ladies. At least 350 plates will be laid.

NEW PUBLICATIONS

ELEMENTARY APPLIED MECHANICS. By Arthur Morley and William Inchley. Published by Longmans, Green & Co., London and New York. Pages, 282; numerous illustrations and tables; cloth. Price, $1 net.

The majority of writers upon this subject fall into the habit of employing calculus to a greater or less extent as a short cut to the end in view. As a matter of fact, however, this often has the effect of obscuring the line of reasoning to the man who has never studied calculus and very often to those who have. In the present case there is a marked absence of such treatment, only elementary algebra and trigonometry being employed.

The subject is handled in a logical manner and is fully amplified by numerous examples carefully selected with a view to their practicability. The chapters dealing with graphical statics and with power are especially instructive, and the use of curves and diagrams is clearly set forth.

Generally speaking, this is one of the best books upon the subject that we have seen, considered from the viewpoint of its adaptability to the needs of the engineer.

THE MECHANICAL WORLD ELECTRICAL POCKET BOOK FOR 1912. Published by Emmott & Co., Ltd., Manchester, Eng. Cloth; 224 pages, 4x6 in.; 80 illustrations; many tables. Price, 8½d., postpaid.

This year's edition contains new sections on verniers and micrometers, roller bearings, helical springs, and new material on other nonelectrical subjects, but the sections on dynamos and motors remain perfunctory and painfully inadequate in both quantity and quality. The mathematical tables remain, as heretofore, by far the most useful feature of the book.

The Mayville Specialty Manufacturing Co., Mayville, Wis., has just issued a 30-page handbook entitled "Horizontal Tubular Boiler Setting." The book treats briefly the work of installing return-tubular boilers and building their foundations and settings. In addition, it contains some useful hints on starting up a new boiler, laying a boiler up and on boiler operation in general. The book also describes the construction of and the manner of installing Monarch fire-door and back combustion-chamber arches. It should be of value and interest to every engineer and may be had for the asking by writing to the company.

BOOKS RECEIVED

HEAT AND THERMODYNAMICS. By F. M. Hartmann. McGraw-Hill Book Co., New York. Cloth; 346 pages, 6x9 in.; 72 illustrations; indexed. Price, $3.

A SHORT COURSE IN GRAPHIC STATICS. By William L. Cathcart and J. Irvin Chaffee. D. Van Nostrand Co., New York. Cloth; 183 pages, 4¾x7½ in.; 58 illustrations; indexed. Price, $1.50.

THE STEAM ENGINE AND TURBINE. By Prof. R. C. H. Heck. D. Van Nostrand Co., New York. Cloth; 631 pages, 5¾x9¼ in.; 402 illustrations; charts; tables; indexed. Price, $5.

MOTORS, SECONDARY BATTERIES, MEASURING INSTRUMENTS AND SWITCHGEAR. By S. Kenneth Broadfoot. D. Van Nostrand Co., New York. Cloth; 96 pages, 4x6½ in.; 16 illustrations; indexed. Price, 75 cents.

PERSONAL

Arthur D. Little, president and general manager of Arthur D. Little, Inc., chemists and engineers, Boston, Mass., was elected president of the American Chemical Society at its annual meeting at Washington. He was vice-president of the society and chairman of the Division of Industrial Chemists and Chemical Engineers.

Arthur H. Gill, associate professor of experimental engineering at the Pennsylvania State College, has resigned to accept a flattering offer in the industrial field. Prof. J. P. Calderwood has been assigned charge of the experimental laboratories in his place, and R. M. Pennock has assumed Professor Calderwood's classes in heat engineering.

Moments with the Ad. Editor

A. B. Gould of Cleveland, Ohio, is one of POWER'S subscribers who takes more than a passing interest in this page and in advertising.

He sent us a clipping from the *Cleveland Press* which shows the opinion of the Cleveland City purchasing agent of the salesmen he meets.

This is it:

"Leave Cigars Behind."

That is the sign at the entrance to the office of A. R. Callow, city purchasing agent. It's right where it catches the eye of a salesman entering the office.

"No, I haven't started an anti-smoking campaign," says Callow. "There are still a few salesmen who cling to the ancient practice of handing out cigars, and the sign is to head them off. I don't like the spirit in which a cigar is offered by a man with goods to sell.

"The wise, modern salesman doesn't hand out cigars. He is a business man who believes in his goods and who assumes that the purchasing agent is intelligent enough to wish to learn something about the merits of a good article.

"And by the way, you can take the words of 90 out of 100 salesmen relative to the goods they handle. They know a lie is soon found out, and that it is fatal to their chances of future sales."

The italics in that are ours and the emphasized portion points this lesson:

Probably no man is in a better position to judge the virtues or sins of a salesman than the purchasing agent of a large city. This one says that 90 per cent. of them tell the truth about their goods because, aside from any moral question, the lie would be fatal to their future chances.

Now, good advertising is nothing more nor less than *printed salesmanship.*

It, too, must be truthful or hurt its future chances beyond remedying.

The two-legged salesman *might* get away with the lie-stuff and hope that the memory of the purchasing agent would prove defective.

But the printed salesman is a recorded thing—it's down in black and white, preserved for all time, ready to be brought out against its perpetrator at any hour. The purchaser who has been buncoed has the *printed evidence.*

Do you imagine for a moment that any advertiser who is in business to stay will take a chance like that and pay real money for the white space in which to do it?

Not on your life!

He'd be a short-sighted crook, to put it mildly.

This matter of truth-telling in salesmanship and advertising is a development of business science.

The modern business man wants to know what will pay him and what won't. When he knows, as he does today, that truthful statements are the ones that win out in the long run he hitches his wagon to that star and stands back of the printed word and the verbal one.

So you, who are interested in the Selling Section of POWER, can read, believe in and buy from the advertisements with a full measure of confidence.

NEW EQUIPMENT

B. H. Adams will construct an electric-light plant in Hillview, Ill.

J. F. Barnes, Maquoketa, Iowa, will install an electric-light plant.

J. G. Smith will install an electric-light plant in McDonough, Ga.

The A. B. See Elevator Co., Jersey City, N. J., will install a new boiler.

Corunna, Mich., has decided to construct a municipal lighting plant.

Hitchcock, S. D., is considering the installation of an electric-light plant.

Bowdoinham, Maine, is considering the installation of an electric-light plant.

Forest, Ont., is considering the installation of a municipal electric-light plant.

O. M. Edwards, Pecos, Tex., will install a pumping plant for irrigation purposes.

Menard, Tex., is considering the installation of an electric-light and ice plant.

Middletown, Conn., contemplates the installation of a municipal electric-light plant.

The Ohio Machine & Boiler Co., Cleveland, Ohio, will buy new power-plant equipment.

The City Council, Electra, Tex., is considering the installation of a water-works system.

The City Council of Woodbury, Tenn., is considering the installation of an electric-light plant.

The Dayton Steel Construction Co., Dayton, Ohio, proposes to erect a $25,000 manufacturing plant.

Murray, Ky., will install a municipal electric-light plant. Bonds have been issued for the purpose.

York, Neb., is considering the construction of a water-works system and an electric-light plant.

Central City, Iowa, is considering the construction of a water-works system. Estimated cost, $10,000.

A bond issue of $125,000 is proposed in Newburgh, N. Y., to be used in extending the water supply.

The installation of an electric-light plant is being considered by F. W. Michel, Orange City, Iowa.

The Perfection Spring Co., Cleveland, Ohio, maker of auto springs, has purchased land for a new plant.

P. W. Elis, Ova J. Henkin and Thomas Dwyer, of Elk Point, S. D., will construct an electric-light plant.

The Municipal Electric Light Plant, at Fairport, Monroe County, N. Y., is planning to increase its plant.

Americus, Ga., is considering the installation of a municipal electric-light plant. Estimated cost, $60,000.

An extension to the water supply to cost $10,000 is proposed in Athens, Ga. J. W. Barnett is city engineer.

Berlin, Ont., has voted bonds for $100,000 for improving the water-works system. A. H. Millar is city clerk.

A franchise has been granted to W. E. Shell & Co., of Port Lavaca, Tex., to construct an electric-light plant.

The Cairo Electric & Traction Co., Cairo, Ill., will construct an addition to its power plant. Estimated cost, $60,000.

The city of Wray, Colo., is considering the installation of a hydro-electric water and light plant. Estimated cost, $60,000.

Colorado Springs, Colo., is considering the installation of a municipal electric-light plant. T. L. Waggener is city engineer.

The City Council, Macon, Ga., will construct a new water-works. Estimated cost, $50,000. C. C. Anderson, city engineer.

The Burden Iron Co., Troy, N. Y., is considering the installation of an electric generator plant. Estimated cost, $25,000.

The plant of the Coteau Power Co., at Vernon, B. C., has been destroyed by fire. The plant will be rebuilt as soon as possible.

Millville, N. J., is considering the construction of a municipal electric-light, heating and power plant. W. F. Ware is Mayor.

The Atchison, Topeka & Santa Fé Ry. Co. will equip its Kingman, Ariz., shops so that all machinery is electrically operated.

The Southern California Gas Co., which is erecting a $75,000 gas plant, acquired a franchise to lay gas mains in the city of Colton.

Fowler, Kan., has voted bonds to the amount of $20,000 for constructing a water-works system and an electric-light plant.

The Selby Shoe Co., Portsmouth, Ohio, will increase its power-plant facilities. A traveling crane will be required among other equipment.

The Dento Salt Co., Stockton, Calif., plans for the erection of a plant for the manufacture of salt. Modern equipment will be installed.

The Beeville Manufacturing Co., Beeville, Tex., is considering the installation of an alternating-current generator and 20-ton ice plant.

The St. Louis, Southwestern Ry. will construct new boiler and machine shops at Pine Bluffs, Ark. C. D. Purden, Tyler, Tex., is chief engineer.

The Wise-Schieble Electric Light & Power Co., Dayton, Ohio, has increased its capital from $50,000 to $400,000. A new plant will be built.

The plant of the Electric Light & Power Co., Alton, Iowa, has been sold to the Mason Plumbing & Heating Co. Improvements will be made.

The Athens State Hospital, Athens, Ohio, will make extensive improvements to its power plant in the spring. Peter Archer is chief engineer.

The city of Cleburne, Tex., is considering the purchase and improvement of the water-works system. Bonds for $178,000 have been voted.

The Bates Manufacturing Co., Lewiston, Maine, is planning the erection of a weave shed, covering 4½ acres. Other enlargements will be made.

The city council, Roswell, N. M., is considering the installation of a municipal electric-light plant in connection with the water-works system.

The L. E. Lumber Co., Greenwood, Calif., will install an electric-power plant in connection with its establishment. C. F. Flinn is manager.

Considerable improvements will be made to the local electric-light plant at Sigourney, Iowa. R. L. Van Meter, Cedar Rapids, Iowa, is interested.

Plans will soon be announced by the Simplex Automobile Co. for the erection of a large plant at Webster Ave. and Pomeroy St., Long Island City, N. Y.

The Moulton Irrigated Land Co., Colusa, Calif., contemplates installing a large pumping plant on the east side of the Sacramento River for irrigation.

A refrigerating plant will be required for the City Hospital, to be erected on Eoff St., Wheeling, W. Va., by the city. Estimated cost of the hospital, $250,000.

The Federal Light & Traction Co., Springfield, Mo., will make considerable improvements to the local electric and gas systems. W. A. Bixby is local manager.

The Avis Oil & Gas Co. has been formed, at Wichita Falls, Tex., with a capital stock of $15,000. The incorporators are J. D. Avis, F. P. St. Clair and L. Solinsky.

The Kirkland-Redmond Ry., Light & Power Co. will build a power house for its proposed line between Kirkland and Redmond, Wash. C. A. Eaton, Seattle, is interested.

The construction of a new power plant is being considered by the Aberdeen Light & Power Co., Aberdeen, S. D. Estimated cost, $200,000. J. T. Burke is superintendent.

The Riverside Portland Cement Co., Riverside, Calif., plans for extensions and improvements in its cement-manufacturing plant during the present year to cost $225,000.

Power plant and manual training equipment will be required for the new school being erected at Crossett, Ark. Frank W. Gibb & Co., Little Rock, Ark., are the architects.

The Floyd Electric Power Co., Floyd, Va., has been incorporated with a capital of $11,000. S. G. Proffit, president; C. W. Vest, vice-president; J. E. Proffit, secretary, Floyd, Va.

C. H. Saville, Hartford, Conn., has prepared plans for a $3,000,000 extension to the Nepang River water system. John L. Dower is president of the Board of Water Commissioners.

W. D. Harmon and McDonald Bros. have purchased the property of the Rogersville Electric Co., Rogersville, Tenn. The new owners will install an entire new power plant.

The Stege, Calif., Cap Works is having plans prepared for a complete new manufacturing plant, comprising nine buildings, for the manufacture of caps for explosives and similar specialties.

The Starr Engineering Co., 50 Church St., New York, N. Y., has completed plans for a refrigeration and ice-storage plant, which will be erected by the Webster-Citizens Ice Co., at Buffalo, N. Y.

The Southwestern Traction & Power Co., New Orleans, La., is considering plans for the construction of two power plants between La Fayette and Berwick Bay. F. W. Crosby, New Iberia, is president.

The Evansville Rys. Co., Evansville, Ind., is considering the purchase of equipment for its new power house at Henderson, Ky. W. A. Carson, Evansville, is general manager and purchasing agent.

Captain A. E. Waldron, Corps of Engineers, United States Army, will receive bids until 3 p.m., Feb. 17, for the purchase of condemned government property, consisting of boilers, steam and oil engines, generating sets, electrical instruments and other property.

BUSINESS ITEMS

A. L. Ide & Sons, Springfield, Ill., are sending out an interesting book on engine construction entitled the "Sketch Book." It shows in detail how Ideal engines are built, and is sent on request.

The Washington Tin Plate Co., Washington, Penn., has recently placed an order with the Westinghouse Electric & Manufacturing Co., East Pittsburg, Penn., for a total of 16 induction motors and a motor-generator set, aggregating 255 hp.

The Murray Iron Works Co., Burlington, Iowa, builders of Corliss engines and all types of boilers, have established a sales agency at Memphis, Tenn. H. M. Jones, located at the Gayoso Hotel, Memphis, will be ready to quote direct upon any equipment made by the company.

A delegation representing the N. A. S. A. recently presented an embossed testimonial to the Lunkenheimer Co., Cincinnati, Ohio. The testimonial was given in token of the appreciation of the members of the Association for the river ride, picnic and barbecue given by the company during the last N. A. S. E. convention, which was held in Cincinnati.

ENGINEERS WANTED

Under this head are published, without charge, advertisements of actual vacancies in power plants for operating engineers and assistant engineers. For the guidance of applicants for advertised positions, the advertisements must contain particulars to show the class of service demanded and the wages paid. Employers who desire to advertise under this head are requested to write for a blank form of application.

WANTED—Electrician who can wind direct-current armatures, fields, etc., and who is competent to design forms for making armature coils and field coils; state wages desired, experience, age, and send references from past employers. Address Box 573, Power.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

SALESMAN — Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," Power.

AGENTS for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

A LIVE SALESMAN wanted to handle a new pipe-threading tool as a side line; a good proposition for a live wire. Address Box 698, Bridgeport, Conn.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesman Address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

CHIEF ENGINEER for new modern power plant; turbine, 800 kilowatts; 2300 volts; every convenience, shower bath; small town, southern New England; $30 per week; age, experience, references. Box 566, Power.

MASTER MECHANIC, in a chemical works near New York City; must be a good all-round man, experienced in the management of boilers, engines, blacksmiths, machinists and general construction work; state age, experience and salary expected. "Chemical," Box 577, Power.

MANUFACTURERS' AGENTS to handle thoroughly guaranteed steam specialties; feed water heaters, steam and oil separators ,traps and exhaust pipe heads; not necessary to represent entire line of interested in only part of it; our specialties are well advertised and of good reputation. Box 569, Power.

WANTED—An experienced mine electrician who can wind armatures and keep in thorough repair, a half dozen direct current generators, a dozen locomotives, and several motors located at different mines; location a plain mining camp, on short branch in central West Virginia. Wanted, by same company, a superintendent-foreman for small mine having an output of 400 tons per day, man who can survey preferred; state age, experience fully, where obtained, in what positions, education and where obtained, married or single, teetotaler or otherwise, and salary expected. Address Box 563, Power.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

CHIEF ENGINEER, desires position in street railway or manufacturing power plant; 15 years' experience; at present employed in charge operating plant; New York City license. Box 576, Power.

AS MECHANICAL superintendent with large manufacturing corporation; good executive, broad experience with Curtis steam turbines and reciprocating engines, generators and motors, both alternating current and direct current; uptodate on boiler economy, shop work and machinery in general. Address Box 574, Power.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

PATENTS SECURED—C. L. Parker, Patents, 904 G St., Washington, D. C.

VOLTAGE REGULATOR wanted for 100 kw., 220 v. alternator with direct connected exciter. Tremont Worsted Co., Methuen, Mass.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. C. P. Monash, 1417 W. Jackson Blvd., Chicago, Ill.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

FOR SALE—One new 300-ton electrically-tilted hot-metal mixer of latest design. Address Box 572, Power.

FOR SALE—Five Corliss vertical water leg, and sixteen Manning vertical type boilers. J. & P. Coats, Ltd., Pawtucket, R. I.

8x10 SKINNER ENGINE, direct connected to 30-kilowatt generator, and 8x10 Allfree engine, direct connected to 20-kilowatt generator . Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

ONE PAIR of Harris Corliss engines, girder frame, approximately 300 hp, diameter of cylinder, 16 in.; length of stroke, 48 in.; diameter of flywheel, 14 ft.; width of wheel, 2 ft. 6 in.; revolutions per minute, 54; engines can be seen at the factory of the Salt's Textile Mfg. Co., Bridgeport, Conn.

LATEST MODEL, heavy duty, 18x42 Brown engine, installed 1904; no reasonable offer refused. This engine has extra heavy frame, wheel and throttle, has special equipment of oil guards, Rochester cylinder lubricator, indicator piping, metallic packing and latest governor and valve-gear improvements, was operated by one of Brown Co.'s former erecting engineers. For sale on account of removal of plant. Box 575, Power.

ONE GENERAL ELECTRIC direct current generator, type A, 4 pole, 45 kilowatt, No. 925, 360 amperes, 850 r.p.m., 110 volt, no load; 115 volt, full load; three horizontal return tubular boilers, makers, Bigelow Co., New Haven, Conn., 20 feet long, 72 inches in diameter, 94 tubes 3½ inches diameter; two horizontal return tubular boilers, makers, Bridgeport Boiler Works, Bridgeport, Conn., 20 feet long, 72 inches diameter, 94 tubes, 3½ inches diameter; one horizontal return tubular boiler, maker, Pacific Iron Works, Bridgeport, Conn., 17 feet long, 66 inches diameter, 68 tubes, 4-inch diameter. All in good condition, 100-lb. pressure allowed on the boilers by the Boiler Insurance Co., at time of removal. Box 564, Power.

Alphabetical Index to Advertisers

	Page
Albany Lubricating Co.	81
Alberger Heater Co.	80
American District Steam Co.	103
American Engine Co.	109
American Engineering Co.	66
American Injector Co.	102
American Mfg. Co.	83
American Metal Hose Co.	83
American Pulley Co.	70
American Steam Gauge & Valve Mfg. Co.	56, 57
Anderson Co., V. D.	92
Armstrong Mfg. Co.	107
Armstrong Mfg. Co., The	94
Ashton Valve Co.	85
Austin Separator Co.	92
Babcock & Wilcox Co., The	98
Ball Engine Co.	110
Baragwanath & Son, Wm.	72
Barnes Co., W. F. & John.	102
Bignall & Keeler Mfg. Co.	86
Blake & Knowles Steam Pump Works	73
Bogart Gas Power Engineerin Co.	107
Borden Co.	85
Bowser & Co., Inc., S. F.	77
Bristol Co.	4th cover
Bruce-Macbeth Engine Co.	107
Buckeye Engine Co.	110
Buffalo Steam Pump Co.	74
Builders Iron Foundry	99
Burt Mfg. Co., The	14
Cameron Steam Pump Works, A. S.	75
Casey-Hedges Co.	98
Chapman Valve Mfg. Co.	88
Chesterton Co., A. W.	80
Columbian Rope Co.	83
Connersville Blower Co., The	75
Consolidation Coal Co.	11
Cooper Co., C. & G.	107
Crosby Steam Gage & Valve Co.	103
Curtis & Curtis Co., The	85
Dallett Co., Thos. H.	99
Dart Mfg. Co., E. M.	82
Daum Co., A. F.	96
Dean Bros. Steam Pump Works	75
Dearborn Drug & Chemical Works	5
De Laval Steam Turbine Co.	104
Deming Co.	74
Detroit Lubricator Co.	78
Diamond Rubber Co.	84
Dixon Crucible Co., Jos.	78
Elliott Co., 7, 72, 73, 78, 85, 87,	92
Engineers Appliance Co., The	88
Epping-Carpenter Co.	75
Eureka Packing Co.	67, 68
Fitchburg Steam Engine Co.	110
Flexible Steel Lacing Co.	83
Franklin Oil Filter Co.	7
Garlock Packing Co.	9
General Electric Co.	113
Goulds Mfg. Co.	74
Graver Tank Works, Wm.	98
Green Engineering Co.	94
Greene, Tweed & Co., 65,	4th cover
Griffith & Wedge Co., The	109
Hamler-Eddy Smoke Recorder Co.	72
Hammel Oil Burner Co.	94
Harbison-Walker Refractories Co.	101
Harris Steam Engine Co., W. A.	108
Harrisburg Foundry & Machine Works	104
Harrisburg Mfg. & Boiler Co.	97
Harrison Safety Boiler Works	59
Heine Safety Boiler Co.	97
Hewes & Phillips Iron Wks.	108
Hoffman, Geo. W.	102
Homestead Valve Mfg. Co.	86
Hooven, Owens, Rentschler Co.	109
Hoppes Mfg. Co.	96
Houston, Stanwood & Gamble Co.	99
Howard Iron Works	85
Huyette Co., Inc., Paul B.	84
Independent Ice Co.	82
Ingersoll-Rand Co.	105
International Corr. Schools	63
Jeffrey Mfg. Co.	83
Jenkins Bros.	61
Johns-Manville Co., H. W.	71
Keeler Co., E.	98
Kellogg Co., M. W.	87
Kennicott Co., The	97
Kerr Turbine Co.	106
Keystone Lubricating Co.	3
Lagonda Mfg. Co.	3d cover
Laidlaw-Dunn-Gordon Co.	106
Liberty Mfg. Co.	7
Locke Regulator Co.	88, 104
Long Grate Bar Co., The	94
Lunkenheimer Co.	4
Lytton Mfg. Corporation	92
McClave-Brooks Co.	8

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Mr. O. J. Gibboney, Erecting Engineer, No. 3 Niagara Square, Buffalo, N.Y., who is now engaged in a responsible position in the erecting engineering field writes us under date of August 1, 1910, as follows:

"In 1906 I was working in a large steel plant for the small sum of $45 a month. I saw opportunities of responsible positions opening up before me almost daily, but I was without the training to take such position.

"Knowing of the I. C. S., I decided to take up a Course and push to a better position. July 9, 1906, I began a Course of Complete Steam Engineering, and 2 months later I was rewarded with an increase in wages of $5 a month. November 1, 1906, I was offered a position in the same plant at a salary of $90 a month. January 30, 1907, I accepted a position at $115 dollars a month, and in July of the same year my salary was increased to $150 a month.

"In the meantime I continued with my studies, completed my Course and received my diploma January 6, 1909, with a very creditable average of 99⅔ per cent. on the complete Course.

"In October, 1909, I again accepted a position netting me $175 a month, and on June 1, 1910, my salary was increased to $300 a month—about 550 per cent. more than the salary I received when first taking up my Course.

"I can only find words of the highest praise for the training the I. C. S. affords."

The complete expenditure, including cost of Course, postage, drawing outfit, drawing paper, answer paper, pens, pencils, etc., was only $86.27.

Would you be willing to make a similar investment that would increase your salary 50, 100, 200, or 500 per cent.?

Every month there are received at the I. C. S. upwards of 300 voluntary letters from students telling of positions bettered and salaries increased through study of I. C. S. Courses. These men are not men of genius—they are not the sort of men known as "gifted," "naturally bright," etc. They are plain men who have applied themselves diligently to their work, and their rise in the world is due solely to spare-time study. The lives of such successful students should be your inspiration. These men are now making their mark industrially and commercially; they have sown the seed of education by enrolling for I. C. S. Courses; they have cultivated knowledge by properly using their spare time on these Courses; and today they are reaping a harvest of dollars, happiness, and contentment.

If you are not satisfied with your present position mark and mail the attached coupon. Doing so will cost you only postage and will place you under absolutely no obligation.

Send the Coupon NOW!

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Please explain, without further obligation on my part, how I can qualify for a larger salary in the position, trade, or profession before which I have marked X.

Steam Engineer	Concrete Construct'n	Sheet-Metal Drafts.
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Boilermaker	Mechanical Draft.	Structural Engineer
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Electrical Engineer	Machinist	Assayer
Electrical Mach. Des.	Toolmaking	Bookkeeper
Dynamo Foreman	Molding	Civil Service Exams.
Electric Lighting	Blacksmithing	Commercial Law
Electric Railways	Civil Engineer	Architecture
Electrician	Gas Engineer	Contracting & Build'g
Telephone Expert	Refrigeration Eng.	Automobile Running

*Name*_____

*Street & No.*_____

*City*_____ *State*_____

*Present Occupation*_____

Vol. 35. No. 5.

OUTLINE OF TOPICS

BRITISH PRACTICE IN SUPERHEATING:

Some of the advantages of using a moderate degree of superheat and descriptions of a number of types of superheater used extensively in England. Victor White.

POWER JAN. 30 Page 138

WIRE ROPE SPLICING:

A simple explanation of the process every step of which is thoroughly illustrated. F. L. Johnson.

POWER JAN. 30 Page 143

CONNECTING ROD ENDS:

The mechanical construction and operation of the various types used by different engine builders. J. A. Levy.

POWER JAN. 30 Page 144

INITIAL CYLINDER CONDENSATION:

The author contends that the initial condensation at admission and the reëvaporation during expansion are not as great as generally supposed. The amount must depend altogether upon the temperature of the metal itself. Prof. Mellanby.

POWER JAN. 30 Page 145

LIGHT ENGINE FRAME FRACTURED:

Interesting repair of fracture in the light frame with which the early hoisting engines were provided.

POWER JAN. 30 Page 146

HEAT TRANSMISSION:

A résumé of the present knowledge of the laws governing heat transmission and results of author's own researches. George A. Orrok.

POWER JAN. 30 Page 147

BOILER EXPLOSIONS IN ENGLAND:

England stands an easy first in the matter of boiler safety, due to the rigid inquiries into explosions and the risk of trial for manslaughter. William H. Booth.

POWER JAN. 30 Page 148

REWINDING AN INDUCTION MOTOR STATOR:

Complete directions for preparing the magnet wire, winding and dipping the coils, taping, shaping and inserting the coils and connecting them up. R. H. Fenkhausen.

POWER JAN. 30 Page 149

PERPETUAL MOTION AGAIN:

H. B. Adcock. Page 153

THAWING FROZEN WATER PIPES:

J. E. Bates. Page 153

THE SINGLE PIPE SYSTEM OF HEATING:

A simple outline of the system with suggestions on method of connecting radiators to risers. William Kavanagh.

POWER JAN. 30 Page 154

PIPING A WATER HEATER:

A. S. Merrill and James E. Noble. Page 155

LEAKY VALVE WASTES HEAT:

C. R. McGahey. Page 156

RADIATOR TROUBLES:

O. G. A. Pettersson. Page 156

EDITORIALS 157-158

A Few Factors in Economical Operation
Six-year Engineering Course at Columbia
Steam Pipe Supports

READERS WITH SOMETHING TO SAY 159-161

VERTICAL CHECK VALVE DID NOT WORK
OIL TRAY STAND
HOME MADE EJECTOR
HOW TO TEST AND TREAT FEED WATER
BLOW HOLE CAUSED CRACK IN SHAFT
DYNAMITE FOR REMOVING PINION FROM SHAFT
FLYWHEEL REPAIR
ISOLATED PLANT ENGINEERS' OPPORTUNITIES

QUESTIONS BEFORE THE HOUSE 162-166

INERTIA OF AIR COMPRESSOR INTAKE
BROKEN VALVE CROSSHEAD
ISOLATED PLANT OWNERS RESPONSIBLE
WHAT MEANS THE DOME?
KNOCKING IN AIR COMPRESSORS
ENGINEERS' WAGES
CHRISTIE AIR STEAM ENGINE
COAL AND CLINKERS
CAUSE OF BOILER EXPLOSIONS
COST OF POWER IN NEW ENGLAND MILLS
THE DELRAY BOILER TESTS
FEED WATER REGULATORS
FIGURES FOR MR. FITZGERRELL

INQUIRIES OF GENERAL INTEREST 167
NEWS 172-173
MOMENTS WITH THE AD. EDITOR 174
ADVERTISING INDEX 54-55

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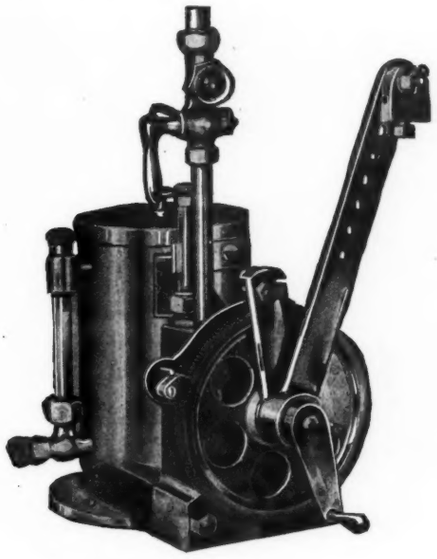

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Their reliable and positive action makes them extremely suitable for the lubrication of the cylinders of all types of steam engines, and pumps as well as air and ammonia compressors. Made in all sizes from ½ pint to 2 gallon and with any number of feeds from one to eight.

Rochester Lubricators are not affected by temperature, pressure, or vacuum. Each feed is regulated independently. Working parts are made of steel and all bearings case hardened. The principal working parts are enclosed and protected from dirt, grit, etc.

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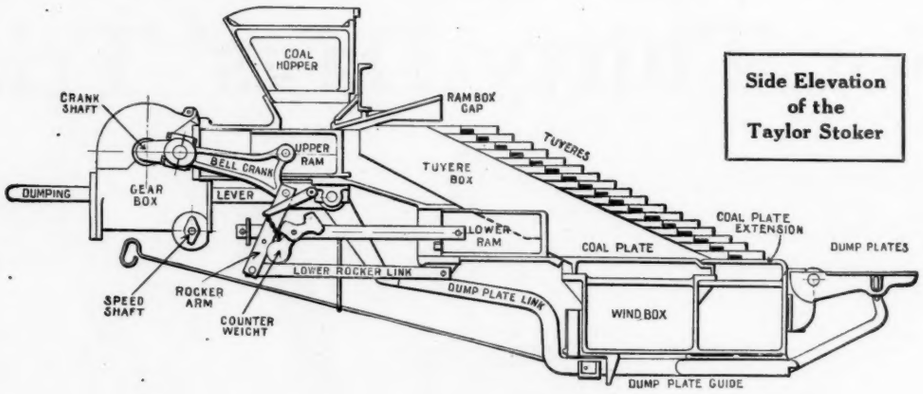
One of these sight feeds is furnished free with each feed of every "ROCHESTER" Lubricator of a capacity of one pint or more.

Improved Vacuum And Check Valve

One of these check valves, as well as a steam nipple, is furnished with each feed of every "ROCHESTER" Lubricator. Special steel check valves and nipples, for use on ammonia cylinders will be substituted if so specified on the order.

COAL—Up The Stack Or Into Steam Which?



Side Elevation of the Taylor Stoker

The Taylor Stoker

Replies to this question decisively.

The Taylor Stoker insures that coal-heat goes *into steam*, every moment the furnace operates.

Not Up The Stack But Into Steam

1. **Because** The Taylor Stoker gives a regulated supply of coal, fed mechanically *under the burning fuel.*
2. **Because** The Taylor Stoker gives a perfectly regulated supply of air, adjusted proportionate to the grade of fuel being fed.
3. **Because** The Taylor Stoker—cutting out hand stoking and *all* cleaning, keeps the fire doors shut, the heat *in the furnace.* More, the great expense of "heating all out-doors" is not present. No air in excess of requirements is admitted.

The result? Perfect regulation of coal and air to each other means *coal burned up*, which, in turn, means—

No smoke—little ash.

Complete combustion also means *the highest heat-efficiency under the boiler.*

With the Taylor Stoker boiler capacities running from 200% to 300% of rating are secured in regular and continuous operation.

You Want These

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New Taylor Stoker Catalog and "Results from Tests." SEND TODAY.

THE TAYLOR STOKER BUILT EXCLUSIVELY BY THE

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SUCCESSORS TO THE TAYLOR STOKER COMPANY, AMERICAN SHIP WINDLASS COMPANY AND WILLIAMSON BROTHERS COMPANY

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